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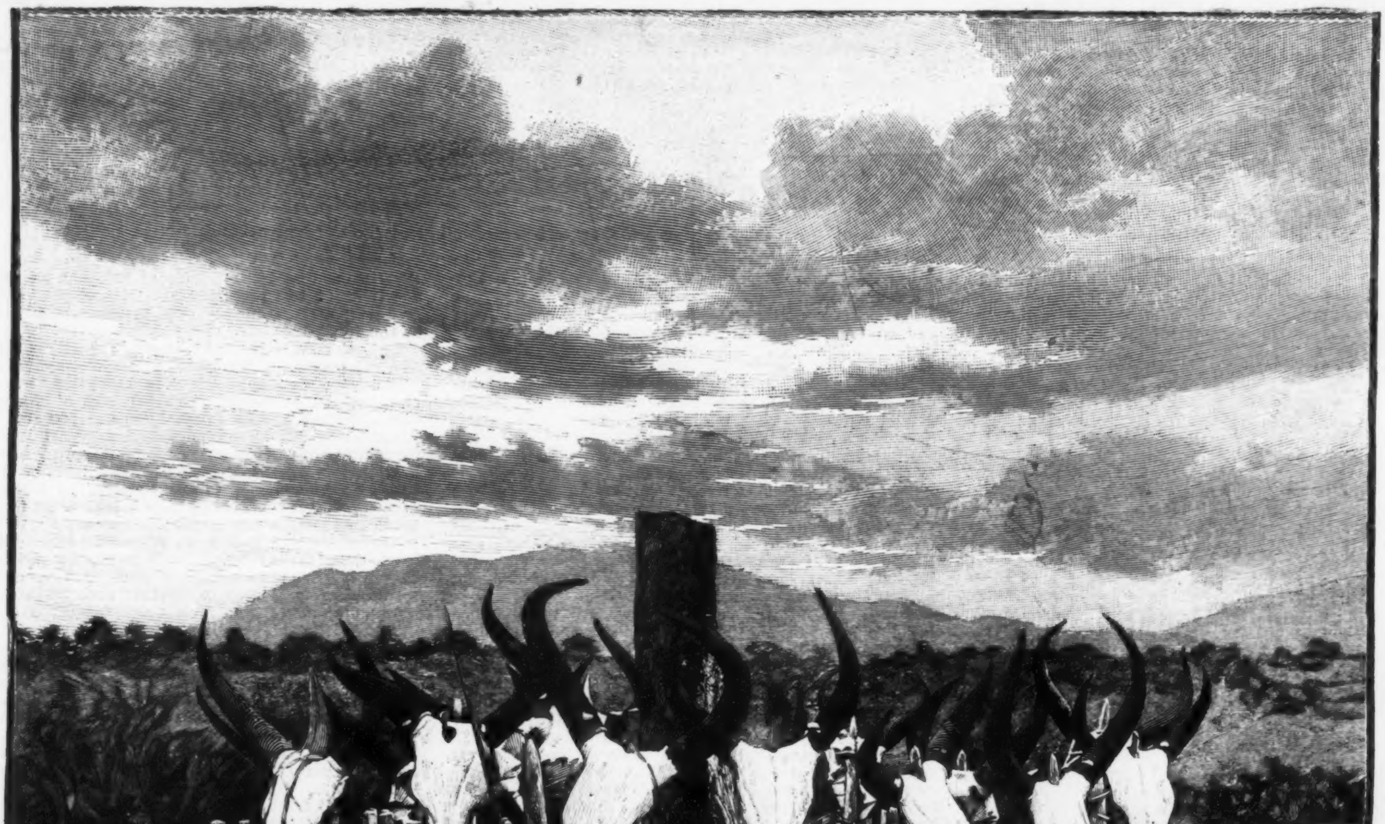


GRAVE OF A NATIVE CHIEF IN MADAGASCAR.

FUNERAL CUSTOMS IN MADAGASCAR.

THE funeral customs of the Malagaches vary according to the tribe. The illustration of a tomb given herewith is reproduced from a photograph taken in the country of the Antanosies near Fort Dauphin in the southeastern part of the island.

The burial places are surrounded with stones placed erect, when any are to be found in the vicinity, but, if these are wanting, with stakes more or less carved and figured and surmounted with ox horns. The tomb here represented is that of a chief, whose great wealth is attested by the number of the ox skulls fixed around the rectangular palisade.

After a person dies, his body is preserved in the hut for several days, during which his former friends and acquaintances unite around the coffin (the skeleton of an old pirogue) in order to sing and dance and make copious libations in his honor. When the day of the funeral arrives, the coffin is covered with rags of different colors, and above the head is placed an umbrella to protect the face against the heat of the sun.

Young girls form the head of the cortege, dancing and singing and marking time by clapping their hands, and sometimes marching around the corpse. The bearers of the coffin stop at certain places and turn it round and round in order to drive away evil spirits. Behind walk the aged, and after them the cattle of the defunct, if he owned any.

The grave, which is not very deep, is immediately after the burial protected by an improvised wall or a palisade, in the construction of which all hands take part. After this, there begins a festival which is prolonged until nightfall.—For the engraving and the above particulars we are indebted to L'Illustration.

REPORT ON THE NEW CROTON DAM AND JEROME PARK RESERVOIR.

THE Board of Engineers appointed to consider the present plans for the construction of that portion of the new Croton Dam on Croton River, at Cornell site, which is designed to be constructed of earth, with a masonry core-wall, and the work of construction thereof, as far as it has proceeded, and also the core-wall and embankment of the Jerome Park Reservoir, has submitted an exhaustive report. The first section of the report deals with the Croton Dam, the second section with the Jerome Park Reservoir.

THE NEW CROTON DAM.

This dam is built across the valley of the Croton River, from north to south, about three miles from the Hudson River. At this point the channel of the river was near the foot of the north bluff, which rose 150 feet in a distance of 350 feet. The face of this bluff was excavated to solid rock and a masonry wall about 1,000 feet long was built parallel to the course of the river, with its coping for 750 feet at the elevation of 200 feet above the level of mean tide-water of the Hudson River, or 150 feet above the river channel, and for 250 feet, at the elevation of 196 feet, forming a spillway for the water which may overflow the dam in freshets. On this portion it is proposed to place flashboards 4 feet high, making the elevation of the water surface ordinarily 200 feet above tide level. On the line of the dam the channel for the water is over a solid masonry wall about 200 feet long at top, abutting against the rock of the hillside at the northern end, and at the southern end against a tower of masonry, in which are placed gates for emptying the reservoir if necessary, the sills being at the elevation of 100 feet above tide.

The bottom of the valley is nearly level south of the river for 400 feet, and the hillside then rises 100 feet in 300 feet and then 70 feet in 400 feet more to the elevation of 220 feet above tide level.

From the waste-way to the point on the hill on the south side of the valley where the surface of the ground was 110 feet above the channel of the stream, a distance of 735 feet, the dam is designed to be built of solid masonry with cut stone faces, from the original surface of the ground to the elevation of 210 feet above tide level or 10 feet above the proposed full water surface of the reservoir. Below the original surface in the valley, the earth and rock have been excavated to a depth of from 120 feet to 160 feet, until solid rock was reached. This pit was filled with rubble masonry, which at the lowest point is 216 feet wide and at the stream level is 120 feet wide and forms the foundation of the dam, the width of which is gradually diminished in accordance with the latest theories of masonry dam construction, until at the full water elevation of the reservoir it is 19.2 feet wide.

In the original plans, it was provided that this masonry dam should be 625 feet long, but on September 16, 1896, it was determined to extend the masonry 110 feet further into the hillside, to its present location, where the solid rock foundation and the natural surface of the hillside are respectively 45 feet and 50 feet higher than at the original location. This change was recommended by the Chief Engineer, Mr. Alphonse Fteley.

At this point, the solid masonry dam terminates abruptly, being there 195 feet high, with a bottom width of 160 feet. At the end, the masonry is built up square, and 150 feet wide. From this point to the southerly end of the dam, a distance of 454 feet, the present partially executed plans provide that the dam shall consist of an earthen embankment 46 feet wide at the top with side slopes of two horizontal to one vertical, and having on its center line a wall of rubble masonry built up from the solid rock, 6 feet wide on top and increasing in width until at and below 150 feet from the top it is 18 feet wide. The slope of the embankment inside of the reservoir is to be covered with a layer of broken stone, on which will be laid a heavy block stone paving. The slope on the down stream side will be sodded.

THE EARTHEN EMBANKMENT.

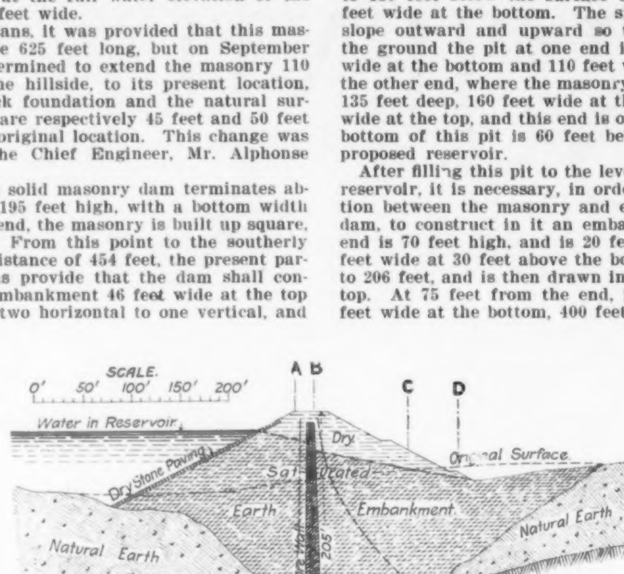
In determining the plan of construction for this part of the dam, financial considerations were doubtless predominant. It has been abundantly proven that up to a height of 60 feet or 70 feet an embankment founded on solid material and constructed of well selected earth, properly put in place, is fully as durable and safe as a masonry wall and far less costly. In this case the foundation is the natural hillside of compact glacial drift.

The design of this embankment is that which has been followed in all the earthen dams constructed in the Croton Valley for the past thirty years. In the center of the bank is built a wall of rubble masonry generally founded on the solid rock, and intended to prevent the free passage of water, but not heavy enough to act alone as a retaining wall for either water or earth. It is endeavored to make this wall water-tight, but in most cases such efforts have not been entirely successful. On each side of this wall is built an embankment of selected earth free from large stones, laid in thin horizontal layers, wet and compacted by carting over, ramming and rolling with heavy grooved rollers.

On the side toward the reservoir, the slope of the bank is paved with stone, the slope of the outer bank is sodded. This is the latest accepted engineering practice in this part of the country for the construction of earthen dams of moderate height to retain the water of reservoirs. The variations which occur in construction are in the steepness of the slopes, the character of the paving of the water slopes and the methods of compacting the material as it is put in place. The plans and specifications for this work are carefully drawn and the material to be used is of such character as to make it certain that if constructed under proper supervision the 300 feet of the dam from the southerly end will be safe beyond peradventure.

The remaining 150 feet, comprising the junction between the masonry dam and the earthen embankment, presents, however, a different problem. The structure at this point is unlike any existing earthen embankment of which we have knowledge. In order to enable the masonry dam to be founded, a pit was excavated to 150 feet below the surface of the ground and 160 feet wide at the bottom. The sides of this excavation slope outward and upward so that at the surface of the ground the pit at one end is 30 feet deep, 20 feet wide at the bottom and 110 feet wide at the top; and at the other end, where the masonry wall begins, the pit is 135 feet deep, 160 feet wide at the bottom and 560 feet wide at the top, and this end is open to the valley. The bottom of this pit is 60 feet below the bottom of the proposed reservoir.

After filling this pit to the level of the bottom of the reservoir, it is necessary, in order to make the connection between the masonry and earthen sections of the dam, to construct in it an embankment, which at one end is 70 feet high, and is 20 feet wide at bottom, 110 feet wide at 30 feet above the bottom, then widens out to 206 feet, and is then drawn in to 46 feet wide at the top. At 75 feet from the end, it is 100 feet high, 50 feet wide at the bottom, 400 feet wide at 40 feet above



Cross-Section of Embankment at End of Masonry Dam.

the bottom and 46 feet wide at top. At the northern end it is 150 feet high, 250 feet wide at the bottom 560 feet wide at 80 feet above the bottom and 46 feet wide at the top.

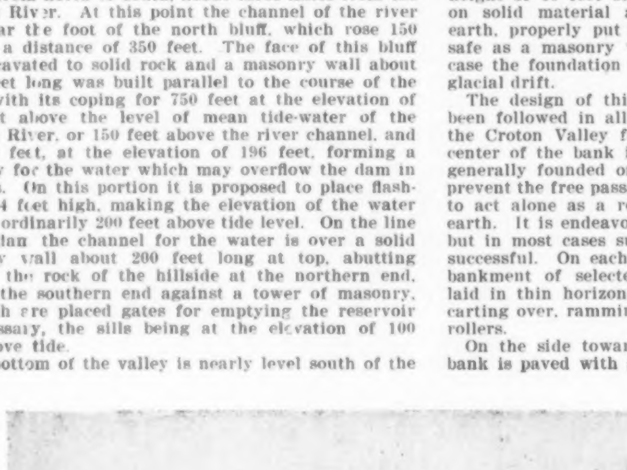
This end abuts against a masonry wall 150 feet wide, and the portion of the bank which extends beyond the masonry on each side has to be supported by a sloping embankment extending down the face of the masonry dam 300 feet on the upper side and 200 feet on the lower side. These supporting banks are conical in form, the base being carried around to meet the natural surface of the ground above and below the dam. This embankment is built up above the original natural surface of the ground to a height of 40 feet at the south end and 70 feet at the north end.

There is no earthen dam of equal magnitude in existence, so far as could be learned, and there were, therefore, no precedents to guide the engineers in forming an opinion as to whether such a structure can be made safe.

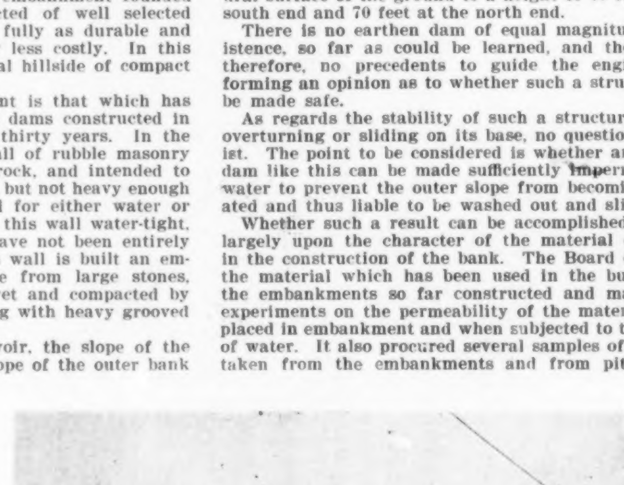
As regards the stability of such a structure against overturning or sliding on its base, no question can exist. The point to be considered is whether an earthen dam like this can be made sufficiently impermeable to water to prevent the outer slope from becoming saturated and thus liable to be washed out and slide.

Whether such a result can be accomplished depends largely upon the character of the material employed in the construction of the bank. The Board examined the material which has been used in the building of the embankments so far constructed and made some experiments on the permeability of the material when placed in embankment and when subjected to the action of water. It also procured several samples of material taken from the embankments and from pits in the vicinity, giving a fair idea of the nature of the materials which have been and which may be used in the banks and had tests of them made by the Hydraulic Laboratory of Cornell University. All the tests indicated that this material, which was found to be almost identical in character with that which has been used in the construction of all the earthen dams in the Croton Valley, is permeable to water under any head from 3 to 150 feet, and that when exposed to the direct action of water it disintegrates and assumes a flat slope, the surface of which is best described as slimy.

On examining the face of excavations which have been made in various parts of Croton Valley, it was observed that the materials composing the glacial drift are not, as a general rule, evenly distributed or intermingled so as to form a homogeneous mass. There are distinct masses of gravel and boulders, beds of sand and finer gravel and large pockets of a very fine sand



END OF MASONRY DAM AND PIT FOR EMBANKMENT, PARTLY FILLED—DOWN-STREAM FACE.



PARTLY BUILT BANK ON LOWER FACE OF DAM.

with a small amount of clay, forming a very compact material when not exposed to the action of water, but dissolving readily and becoming quite fluid when water reaches it. On inspecting the hillsides along the valley of the river above the New Croton Dam, instances may be seen where it is plain that the ground water has at some quite recent date penetrated to such a pocket of hard-pan, as it is termed, dissolved it, carried it to the face of the nearest steep slope and sloughed off the face, causing a landslide of the super-incumbent mass of more solid material.

In a well-built earthen dam, the various classes of material are thoroughly intermingled, forming a mass better adapted to resist such action by the water of percolation, but it is never safe to permit such water to appear on the outer slope of the embankment.

In seeking information as to the actual saturation of high earthen embankments, no recorded data could be found as to the penetration of water into embankments and the slope assumed by the water in passing through banks of earth artificially constructed with care.

There are in the Croton Valley six earthen dams of heights varying from 50 feet to 90 feet which have been in use for from three years to twenty-three years. Pipe wells were driven into them at different points and the elevation at which the water stood in such pipes noted.

In all of the dams on which observations were made, the entire bank on the water side of the core-wall appears to be completely saturated. On the opposite side of the core-wall, water was found to be standing in the embankment in every case.

On applying the data obtained from these tests to the proposed cross section of the New Croton Dam embankment, it appears that taking the loss of head in passing through the core-wall and the slope assumed by the water of saturation in each case examined, the maximum safe height of an earth embankment with its top 20 feet above the water level and its outside slope two to one, would be:

On the basis of the Middle Branch Dam loss of head and saturation, 63 feet; Bog Brook, 100 feet 6 inches; Titicus, 82 feet 3 inches; Amawalk, 72 feet; Carmel Dam, 102 feet 5 inches.

In embankments of greater height than these, the outer slope would be saturated and the dam unstable and unsafe.

The Board is of the opinion that the observations made at the Bog Brook Dam, the oldest, and the Carmel Main Dam, the most recent of those built by the Aqueduct Commission, furnish a fair criterion of assuming the probable saturation of the outer embankment of the new Croton Dam, provided that the core-wall and the embankment were built in accordance with the plans and specifications in every respect, and the foundation was on level rock.

The slope of the surface of the saturated water in the bank is determined by the solidity of the embankment. The more compact the material of which the bank is built, the steeper will be the slope of the saturation. The evidence of the Middle Branch, Bog Brook and Carmel Dams is to the effect that the bank below and adjoining the core-wall in the course of a few years becomes saturated up to 83 per cent of the depth of the water in the reservoir, and that the slope of saturation in the best embankment made of the material found in the Croton Valley is about 35 feet per 100 feet, and that with less carefully selected and placed material the slope may be 20 feet per 100 feet.

Comparing all the data obtainable of the material employed and the work already done, the Board believes that in the new Croton Dam embankment the loss of head caused by the core-wall may be assumed to be 17 per cent of the depth of water in the reservoir or 21 feet, and that the slope of saturation may be assumed at 20 feet per 100 feet.

On this basis, which is a liberal one, the maximum height to which an earth embankment, with its top 20 feet above the water line and with outside slopes of two to one, can be built with safety is 70 feet.

From our observations, experiments and tests of the material used in the embankments already made and the manner in which it has been put in place, we are of the opinion that the saturation in the high embankment adjacent to the masonry dam would more nearly approach the Middle Branch rate than that of the Bog Brook and Carmel Dams and that, at any rate, the 150 feet of bank adjoining the end of the masonry dam would in time become unstable and unsafe if built as designed.

The trouble might be overcome to some extent, by flattening the slope of the banks and adding about 300,000 cubic yards of embankment, so as to bring the probable slope of saturation not less than 10 feet below the surface of the bank. This would extend the toe of embankment some 250 feet further into the valley, would add largely to the cost and would disfigure the appearance of the dam.

Or the lack of stability might be to a considerable extent overcome by facing the lower slope with a revetment of heavy block stone paving with a backing of broken stone. This too would disfigure the dam and add largely to the cost.

In either case, the permanent stability of the bank would be still a matter of great doubt, for it must be borne in mind that this immense bank is founded partly on a rock surface sloping down toward the valley at the rate of 50 feet in 100 feet, and partly on the excavated face of a bank of the natural earth which in turn rests on the same sloping rock surface. The permeability and character of this natural earth bank are unknown except where it has been cut into, and there it is found to contain a large proportion of "hard-pan," interspersed among beds of gravel and boulders. The thrust of the embankment at its toe is resisted by a mass of miscellaneous material, dumped in and wet, but not rammed or rolled, to a depth of from 100 to 150 feet above the underlying rock. The character of the first 50 feet in height of the embankment, which has been placed on the lower side of the dam, and its behavior under exposure to the weather, will be best understood from inspection of the accompanying photograph.

Supposing that an embankment 70 feet in height may be constructed on the plans and of the material demanded by the specifications for the New Croton Dam, if founded on rock or on solid earth, with absolute assurance of its stability and permanency, an element of uncertainty is introduced when such an embankment is placed, as it is here proposed to do, on top and at the edge of an artificial bank of earth 100 feet high, built in detached sections, as this bank must necessarily be built, and sure to be saturated with water from a reservoir 125 feet deep behind it, and the ground water from a steep hillside adjoining it. This uncertainty arises chiefly from the fact that the settlement of a bank thus constructed must be very irregular and the liability to cracking and deformation great, being built at different times and of various kinds of material. There is no way in which such irregular settlement can be avoided. It will take place largely during and after the filling of the reservoir with water, and there is no way in which cracks in the embankment which may have once opened to permit the passage of water can be closed. The percolation of water through the bank, at any but the lowest velocity, would endanger its stability beyond repair, and no amount of additional earth placed upon its slopes would suffice to make it permanently stable.

This doubt as to its permanent stability is sufficient to condemn this plan of construction for this important structure, on the permanency of which the safety of the water supply of New York depends.

The only alternative is the continuation of the masonry dam of its full section, for the remaining portion of the work. The extreme southerly end, about 140 feet long, south of the gatehouse controlling the inlet to the old aqueduct, where the top of the dam would be 30 feet above the natural surface, might be made an earth embankment. The additional expenditure required to change the 290 feet between the gatehouse and the present end of the masonry dam from earth to masonry would be about $400,000.

(To be continued.)

NEW RESEARCHES ON THE NEUTRALIZATION OF PHOSPHORIC ACID.*

IN pursuing physiological chemical researches on the acidity of the liquids of the body, I have been led to undertake the study of the neutralization of acids in multiple functions, organic and mineral, and chiefly that of phosphoric acid. I had previously discovered in this acid three distinct functions: that of a monobasic acid, comparable to the most energetic mineral acids; then a weaker acid, of the order of acetic acid; and a third acid, of the order of that of the alcohols. These three acidities correspond to the formation of monobasic, bibasic and tribasic phosphates. They are manifested as much in the inequality of disengagement of the heat of neutralization, which characterizes each of them, as by the diversity of tint of certain colorants, such as methylorange, evidencing the monobasicity; phenol-phthalein, evidencing the first two basicities; and the blue $C_4 P$ evidence, though a little uncertain, of the third basicity.

My new researches have been directed to the double decompositions of the chlorides of calcium, barium and magnesium and the nitrate of silver, opposed in different proportions to free phosphoric acid, and to the monosodic, bisodic and trisodic phosphates, as well as to the monoammoniac, biammoniac and triammoniac phosphates, for the purpose of determining the corresponding variations of acid percentage. Before presenting the detail of these experiments, whose number amounted to hundreds, I will consider the direct neutralization of phosphoric acid by lime and by baryta.

The new results obtained have confirmed and supplemented former ones, adding to them certain phenomena, which appear of interest as connected with the general problem of neutralization.

1. A solution of lime, containing for example, 1.2 gramme to 1.4 gramme to a liter ($CaO = 40$ liters to 50 liters), is poured slowly from a graduated burette into a solution of phosphoric acid ($PO_4H_3 = 8$ liters). No precipitate occurs at first; but the methylorange attests the neutralization when an equivalent of alkali has been attained for a molecule of acid, precisely as with soda and with baryta; that is, $PO_4H_3 + NaOH$ for soda; $2PO_4H_3 + BaO$ and $2PO_4H_3 + CaO$ for lime and baryta (bivalent bases). If the solution of lime is still added rapidly, the acid commences to be precipitated in the form of bibasic phosphate, $5PO_4CaH$ or P_2O_5 $2CaO\,H_2O$, the precipitation being almost complete with two equivalents of lime (one molecule).

Yet the reaction does not stop at this limit, a new proportion of lime being attached to the precipitate, according as the alkaline solution is added. Now, a remarkable circumstance, the increase of lime in the precipitate is not instantaneous, but progressive: it occurs a little after, and is only completed very slowly, even when the acid is put at once in presence of a considerable excess of lime, such as 4 CaO and even 10 CaO (8 or 20 equivalents). This is noticed by allowing the liquid to rest, when it quickly becomes clear, or by filtering it. With longer delay the precipitate changes in nature, and the material, again put in suspension by shaking, is deposited again very slowly, remaining emulsionized in the manner of a colloidal body. In working from the beginning, a determined fraction of the initial volume† may be isolated and the alkaline portion ascertained by the use of normal chlorhydric acid, for example, and of a colorant. Methylorange has been used preferably. As soon as all the phosphoric acid has been precipitated, which is effected by a proportion of lime a little superior to two equivalents (CaO for PO_4H_3), the clear liquid contains only lime and the indications of the three colorants; methylorange, phenol-phthalein and turnsol respond essentially to the same limit. This limit makes known the proportion of free lime in the solution, and by difference, the quantity precipitated by the phosphoric acid.

2. By gradually pouring the lime water into the phosphoric acid the methylorange turns, as I have just said, toward the state $P_2O_5 : CaO$ (soluble monobasic phosphate).

By working in the opposite direction, that is to say, pouring the phosphoric acid gradually into the lime water, the turning takes place toward the state P_2O_5: CaO, that is to say, from the time of the formation of the insoluble bibasic phosphate, which takes away two equivalents of base soluble by alkalimetric action.

With phenolphthalein, the first limit is less clear; it has appeared near 1.4 CaO.

3. To better observe the progressive fixation of the lime on the bibasic phosphate precipitated in the first place (PO_4CaH or P_2O_5, 2CaO, H_2O), I have instantly effected the mixture of the solution PO_4H_3 with a volume of lime water containing 4CaO and 10CaO (8 + 20 equivalents).

Making use of methylorange, the following percentage of lime fixed on PO_4H_3 has been observed:

	With 4CaO.	With 10CaO.
	1.34	1.77
First day............	1.82	1.93
Second day..........	1.89	—
Third day............	1.93	1.96
Fourth day..........	1.97	—

The last figures correspond nearly with the formula of a quadribasic phosphate.

The estimation, executed simultaneously with three colorants, has been found essentially the same, in two distinct trials.

Methylorange	1.77	1.95
Phenolphthalein	1.80	2.02
Turnsol	1.77	1.96

When it is shaken, the precipitate enters into suspension again, and the emulsified liquid scarcely becomes clear, even after some weeks of repose. But if several hundredths of its volume of a saturated solution of sodium chloride is added, the precipitate coagulates and separates. According to the titration of the clear liquid thus obtained, the precipitate contains for PO_4H_3: 1.99 CaO.

The liquid can also be made clear by keeping it at 60 deg. in a closed vessel for six hours. The next day the estimation by methylorange has indicated for PO_4H_3, the proportions of lime precipitated: 2.1 CaO.

The light excess, 0.1, may be attributed to the precipitation of the lime water occasioned by the action of heat. In fact, the same amount of the same lime water, heated simultaneously by the same bath, has lowered the amount from 1.16 gramme to 1.12 gramme per liter.

According to these facts, which agree with my previous observations, making them more precise, the condition of three equivalents does not represent the limit of the saturation of the phosphoric acid by the lime, any more than by soda, which continues to disengage a little heat, even beyond the proportion $PO_4H_3 +$ 3NaOH. The same is the case with baryta.

A calcic quadrivalent compound (Isoklas) has even been observed in nature (Gmelin, t. ii; p. 364). This compound would correspond to calcium oxychloride, $CaCl_2,3CaO$ + to basic calcium nitrate, Az_2O_6Ca,CaO.

4. Baryta gives occasion for similar observations. When a solution of baryta is poured gradually into phosphoric acid, the turning of the methylorange corresponds to the soluble monobasic salt $P_2O_5,BaO,2H_2O$ as is the case with soda and lime.

Operating in the opposite direction, a progressive fixation of alkali on the bibasic salt PO_4BaH has been noticed.

First effect.........................	1.33 BaO
Then	1.45
In 24 hours..........................	1.725
After some days......................	1.91

I have not succeeded in passing beyond this limit, but it nearly approaches a quadribasic phosphate.

When the tribasic phosphate, $P_2O_5,3BaO$, is precipitated by double decomposition, it is amorphous at first, then crystallizes, disengaging + 14 Cal., according to my old observations.

When calcium and barium phosphate are precipitated by double decomposition, I observed that the precipitated salt varies, according to the constitution of the initial soluble alkaline phosphate, its relative proportions, and other diverse circumstances in its degree of saturation. There can be obtained:

Either a bivalent salt, such as PO_4CaH, or PO_4BaH;

Or a trivalent salt, such as $P_2O_5,3CaO$, or P_2O_5, 3BaO;

Or a salt of intermediate saturation, such as those observed by Berzelius;

Or a double salt, such as $P_2O_5 2BaO.2NaOH$ and the analogous compounds obtained by the regretted Joly.

Lastly, if the operation is conducted with an excess of potash or of soda, quadribasic phosphates, or their mixture with tribasic phosphates, may be obtained.

By reason of these facts, of which I have made a thorough study, the changes in the degree of neutrality of the liquids decanted or filtered are very different, according to the circumstances, and they do not correspond in the majority of cases to the formulas accepted on hypothesis by the physiologists.

* From the French of M. Berthelot. Communication presented to the Academie des Sciences.

† Because of the great dilution of the liquids, their volume, by the effect of the formation of the precipitate, only experiences insensible variations, at least for the degree of precision of alkalimetric experiments. The filters used were formed of the white paper employed for chemical analyses. This paper only retains insignificant quantities of alkali, that is to say, comprised below the limits of error, as is determined by comparing the filtered liquids with the liquids isolated by decantation. The liquids should be prepared and preserved in closed vessels free from contact with the air.

RAILROAD MATERIAL IN CHILE.

Consul-General Hughes, of Coburg, under date of October 26, 1901, says:

According to a semi-official report, the Chilean Senate has passed a law by which the administration has at its disposal 11,150,000 pesos ($4,069,750), to be drawn within four years, for the purchase of engines and cars; also, for the building or enlargement of repair shops, as well as for the maintenance of the railroad lines, the bridges, and other parts of the government railroad. It is further stated by this law that the Chilean Government is not bound to buy its supplies entirely from the inland workshops. This leaves an opening for outsiders, of which our manufacturers ought to take advantage.

Varnish for Copper.—To protect copper from oxidation a varnish may be employed which is composed of carbon disulphide 1 part, benzine 1 part, turpentine oil 1 part, methyl alcohol 2 parts and hard copal 1 part. The varnish is very resisting; it is well to apply several coats of it to the copper.—Die Werkstatt.

A NEW FEED-WATER REGULATOR.

THE accompanying illustrations show a system of feed-water regulating apparatus which has been introduced by the "Reliance" Patent Feed-water Regulator Company, of Glasgow, says The Engineer, to which we are indebted for the engravings. It has been specially devised for application to those types of boilers which contain a comparatively small quantity of water. Of course the danger in all automatic devices of this description is that they should fail to work. On this point we can say, in connection with this apparatus, that a number have been fitted and are at work, we are informed, satisfactorily; that one of our representatives has visited the works where the appliance is made, and has examined all the parts when opened up, and has also, on more than one occasion, seen it in operation on the boilers in the Court House at Glasgow. On the occasions of his visits he reports that the apparatus was working satisfactorily. We raised several points in connection with different parts of the mechanism where we thought trouble might arise, but the makers' replies to these were reassuring, and we shall refer to them at length when we have described the mechanism.

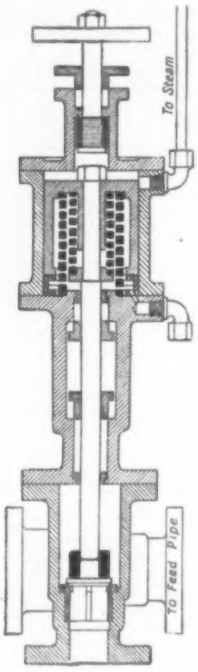


FIG. 1.

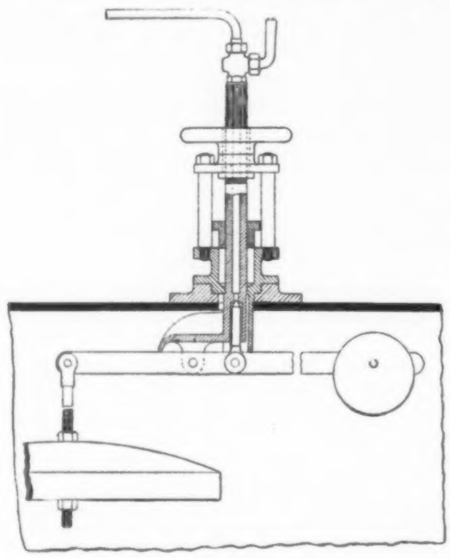


FIG. 2.

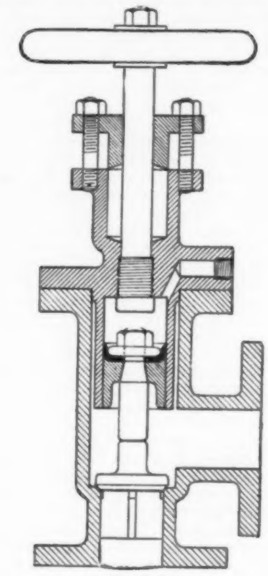


FIG. 3.

The regulating arrangement consists, in the first place, of a pin valve, inside the boiler drum, which is worked by a lever operated by a float and weight. The float and balance weight are so arranged that if the water does not raise the float the valve is open, but that on the water rising and lifting the float the valve is closed. The second part of the apparatus consists, as will be seen in Fig. 1, of a special form of check valve, which is provided with a steam-regulating cylinder. The cylinder is fitted with a deep piston, having but a small length of travel, and a long gun-metal rod passing through two stuffing boxes to the check valve. The piston is capable of movement in the cylinder and also on the piston-rod. There are two coil springs inside the piston. One of these, which rests on the bottom of the cylinder, by pressing against the under side of the piston keeps it at the top of the cylinder when no steam is admitted through the needle valve. The underside of the piston has a valve face attached to it, and a corresponding face is screwed to the lower cover of the cylinder, so that when the piston is pressed downward it comes into contact with the lower face and prevents any escape of steam. The piston has a small amount of vertical travel on the piston-rod, and ordinarily when no steam pressure is on it is kept pressed against the nut screwed on the end of the piston-rod by means of a second coiled spring, which is carried between the underside of the piston top and a collar on the piston-rod, as can be readily seen in the illustration. A drain outlet is provided at the bottom of the cylinder to carry off any condensed steam when the piston is up. The upper portion of the cylinder is connected to the pin valve on the boiler by means of a steam tube.

With so much explanation we can proceed to discuss the method of working. When the water in the boiler rises above a given point the float, Fig. 2, is lifted, and the pin valve is opened. Steam passes through it, and is admitted to the upper part of the cylinder controlling the check valve. The piston descends till the end of the spindle rests on the check valve, compressing the outer spring only as it does so. The travel of the spindle being thus arrested, the piston itself continues to be forced down, thus compressing the outer and inner springs till the valve faces, formed on the piston and the lower cover, meet. When the water again falls in the boiler the float falls with it, and the pin valve is closed. The steam in the pipe and cylinder then condenses and the piston is forced upward by the springs, which no longer have to contend with the steam pressure. The result is that the check valve is free to pass feed-water into the boiler. We are informed that in practice it has been found possible to keep the water-level from fluctuating more than $\frac{1}{2}$ inch, that is $\frac{1}{4}$ inch above or below a given level. If it is desired to fill up the boiler above the working level, the steam is shut off by the small cock on the supply pipe, and if at any time the water is required at a lower level than usual, the piston and spindle can be screwed down by means of the hand wheel on the top of the regulator, just in the same manner as an ordinary stop valve.

In some cases where it is desirable to be able to alter the working level of the water while the boiler is under steam, an arrangement is supplied whereby the whole float gear with its valve can be raised or lowered from the outside. Fig. 2 shows how this is brought about. The bracket carrying the front gear has a tubular extension projecting upward through a packing gland on the boiler. This extension is screwed, and can be moved up and down by means of a nut and hand wheel. The whole float gear can therefore be put in any desired position.

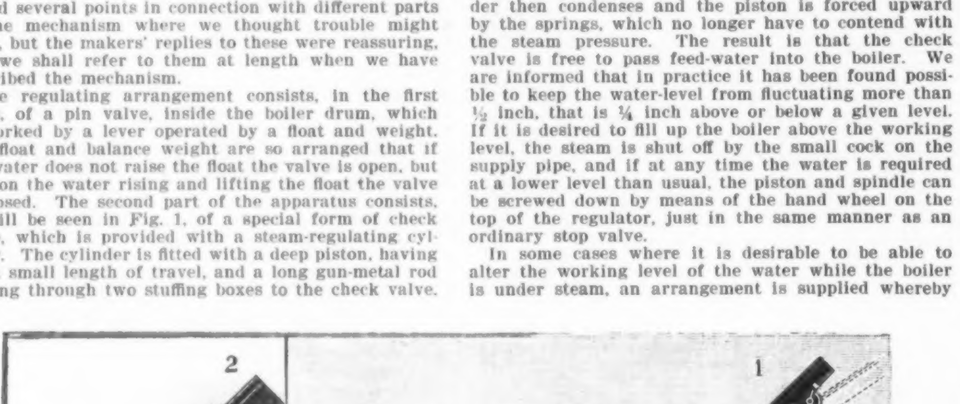
In applying this feed-regulating apparatus to a row of boilers, the feed pump is kept constantly at work, and it may sometimes happen that all the regulators are shut down at one time. Without some means of relieving the pressure this would put a heavy strain on the feed pipes and joints. A relief valve is, therefore, connected to the pipes, and is set to work at about 10 pounds above boiler pressure. The overflow from the relief valve is generally taken to the tank from which the pump draws its supply.

When in the nature of the circumstances of working the boiler pressure fluctuates greatly, it is sometimes found that an ordinary spring relief valve set to work at the maximum steam pressure cannot be opened by the pump when the steam pressure is low. If nothing were done naturally the pump would stop. It is, of course, desirable that the pump should always be in motion, and another form of relief valve has been designed which adjusts itself to variations in the steam pressure. This valve is shown in Fig. 3, and is similar in its action to the regulator already described. A small cylinder takes the place of the ordinary spring, its area being slightly in excess of the area of the valve. The boiler pressure is conveyed to the outer end of this cylinder. The idea is that, however much the pressure in the boiler may vary, the relief valve is always held down by a pressure slightly in excess of that on its underside, as long as the feed-water has access to the boilers. The makers claim that the whole apparatus is particularly adapted for use in electric light and power stations.

One of the points we raised with the makers was as to the effect of dirty water. In reply to this they assured us that as the working parts of the regulator are completely cut off from the water in the boiler, no water, save that due to condensed steam, can get into contact with them. Further than this they say that there is no tendency for the piston to stick, since it is kept moving up and down every few minutes. The springs which lift the valve exert an upward pressure of about 500 pounds. The only time, they inform us, that the piston is likely to get fast is after a holiday stoppage, if the attendant has neglected to oil it. Even in this case it is easily freed by pouring in a little thin oil and moving down the piston by means of the screw and hand wheel on the top. Another place where we feared that trouble might arise was in the needle valve. We are assured, however, that no trouble has been experienced save in one instance, when the water used was so foul with coal tar and other matter that all the boiler fittings were choked up and there was so much sediment lodged in the boilers that about five barrow loads were removed from each boiler every six weeks. With this exception, they have no record of these valves getting out of order, and they inform us that they have a number of valves of this type which were fitted ten years ago and are still in use. The whole apparatus as now made has been at work for more than a year in different places with pressures varying from 60 pounds to 120 pounds.

A NEW EXCAVATOR.

WE represent herewith a new excavator recently invented by Mr. Harvey C. Lowrie, of the American Society of Civil Engineers, and presenting a number of very interesting peculiarities. It is of very plain construction and needs no railway upon which to shift it from one spot to another, as is usually the case; it serves for immediately loading dump-carts or other vehicles, and it takes up but little space and works in all directions.



NEW EXCAVATOR.

1. General view of the apparatus. 2. Details of the discharging hopper.

The apparatus is here represented digging a trench, or, rather, with its metal spoon, gathering up the earth from a side cutting. The apparatus carries its installation of motive power along with it, for in the tripod, mounted upon wheels and forming the principal frame, may be seen a boiler, the water reservoir of which is quite near, and which sends its steam to a small motor placed horizontally upon the carriage. Suitable transmissions permit of rendering this carriage self-moving, and the more so in that the entire affair does not weigh more than 8 or 10 tons. The wheels that usually support it may be removed when need be and the carriage be mounted upon four rollers that will assure its motion in a direction at right angles with that of the large wheels, in order to form an excavation lengthwise. The principal and most interesting arrangement of this apparatus is the large inclined area, with a slight bend at its extremity, which rests above upon the summit of the tripod and below upon a nearly horizontal cross-piece that may be seen to the left of the figure, and on which moves a carriage that carries the engineer of the apparatus. On another hand, this cross-piece forms also a path for the rollers that support the large excavating arm. This latter, which is formed of U-irons, is capable of pivoting and sliding in the mounting of the upper part

in moving upon the rollers above mentioned and under the traction of chains wound around capstans under control of the engineer. The displacements of the excavating arm in the direction from right to left are caused simply by the displacements of the engineer's carriage, which, through a gear wheel and rack, rests upon the horizontal cross-piece, which in reality is composed of two parallel pieces. The spoon of this excavator has a very peculiar form, as may be seen from the figure. It displaces itself by moving, through four small rollers, upon the lower part of the large arm. When charged, it is raised by a chain that extends to the upper part of the apparatus and winds around a capstan. It redescends under the influence of gravity solely. When it reaches the end of its travel, its bottom opens automatically and its contents fall into a hopper, and the inclined plane carries the material to wherever may be desired (say to cars or dump-carts) or empties it upon an endless belt that carries it to a distance. It is even easy to conceive of an arrangement that will permit of filling up a trench in measure as the work of excavation advances, as has to be done in the laying of water or gas mains.

The curve in the arm forming a rolling path for the spoon is given for the purpose of affording a means of moving the spoon horizontally over the ground, either when an excavation is being begun (while the arm is raised in the position shown by dotted lines in Fig. 1), or for attacking the bottom of a cutting in measure as it is desired to deepen it. The front of the spoon is provided with two metallic plates that play the part of the colter of a plow in cutting the earth and dissociating it so that it may enter the spoon.—For the above particulars and engravings we are indebted to La Nature.

CRANE WEIGHING MACHINE; GLASGOW EXHIBITION.

MESSRS. W. & T. AVERY, LIMITED, Soho Foundry, Birmingham, have a large exhibit at Glasgow of their special types of weighing machines, and we illustrate herewith one of the most interesting of the novelties shown—a machine to be carried on the hook of a crane for weighing castings, armor-plates, molten lead in the ladle, and other such loads when suspended from the crane. The suspension loop is bolted to a strong wrought-iron frame or body from which all the levers carrying the load are hung.

The machine, as shown by the illustration, consists of a wrought-iron box, *A*, inclosing the weighing levers, *B B*. These levers are suspended from the strong wrought-iron frame *C* by means of the links, *D D*. The suspension loop, *L*, is directly connected and bolted to the frame, *C*, and additional safety is secured by turning the lower portion of the loop under the frame. In this machine none of the levers depend upon the containing box for their support. The levers are all fitted with hardened steel knife-edges, and the links have hardened steel bearings. The main knife-edge, from which the load is directly hung, is supported along its whole length by the main lever, thus obviating the possibility of the knife-edge breaking and letting the load fall. A cover-plate, removable while the machine is in use, is placed over the side of the machine, thus insuring that the levers and internal parts will be free from dust. The steelyard, *S*, is of wrought iron, dispensing with loose weights, and the sliding poises, *P P*, are of gun-metal. An adjustable ball, *F*, for balancing is affixed to the steelyard, and is protected from injury by a strong wrought-iron guard, *G*.

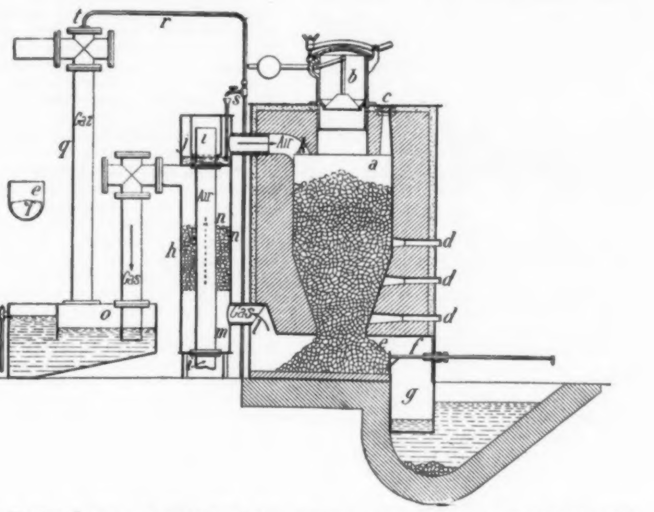
The general design allows of the front cover-plate being removed for the examination and cleaning of the working parts while the machine is in its place for use; thus avoiding the time and expense of removing to the shops, and taking the machine to pieces by a skilled mechanic. The indicating steelyard is arranged to dispense with loose weights, and provision is made for tearing off chains, slings, or cam hooks.—We are indebted to London Engineering for the engraving and description.

GAS GENERATOR WITH REVERSED COMBUSTION.

AN endeavor has been making during the last few years to utilize wood in generators that are designed to supply gas for motors. It is certain that, as a general thing, three pounds of wood contain nearly the same number of heat units as one pound of ordinary coal; and, since the advance in the price of the latter, there are many regions in France and other countries where two and a half pounds of wood have been costing less than one pound of the mineral fuel.

Besides, "there is wood and there is wood," and the refuse, stumps and pieces of too small a size to be employed in carpentry and joinery are often of slight value.

Unfortunately, wood is the fuel that is richest in products of distillation. It comprises about 50 per cent of carbon, 5 to 6 per cent of hydrogen and 44 to 45 per cent of oxygen, with a little sulphur and nitrogen. In chemical composition, it resembles cellulose and is often charged with water. As well known, the products of distillation, so valuable as chemical products, when they are collected in works specially arranged and fully equipped with apparatus for the purpose, cause a very great embarrassment when it is desired solely to convert the solid combustible (wood) into a gaseous fuel for heating purposes or for the supply of motors. An endeavor has been made to effect such conversion and the purification of the gas by causing the products of distillation to pass over red-hot coke. We know, in fact, that red-hot coke decomposes the carburets and tar and converts them into carbon and hydrogen, and that, when the tar traverses the coke with aqueous vapor, the high temperature of the coke facilitates mixed combinations of the elements of these two products, and tends to decarburet the tar and produce carbonic oxide. It would be well, then, to pass the gas derived from the distillation of wood over red-hot charcoal, since the latter is the coke of wood; and the first idea that was adopted (a very ingenious one) was to heat the wood in a vertical retort and reverse the distillation, that is to say, cause the gas produced at the top of the retort to pass over red-hot charcoal at the place at the bottom to which gravity has carried the distilled wood, and where the temperature is the lowest. Another process, subsequently proposed, consists in a return to the type of the ordinary gas generator, that is to say, to that in which the air acts directly upon the fuel without necessitating the use of an external furnace; and, in this case, in order the more easily to obtain the same result, the combustion is reversed, that is to say, is produced from top to bottom.



THE FAUGÉ GAS GENERATOR, WITH REVERSED COMBUSTION.

We have recently had an opportunity of inspecting such an apparatus, which is installed, and has been tested, in one of the largest works of France, where it has been employed for several months for the supplying of gas motors and has given most satisfactory results. It supplies two 50 horse power motors. Another generator, which is in course of construction, is designed for a motor of 200 horse power.

The consumption per horse hour is sensibly less than 5 pounds of wood, neither air nor kiln-dried. This gas generator is represented in the accompanying figure. At *b* is seen the charging hopper that permits the wood to fall into the body *a* of the generator. The air, sent by a blower at *i* follows the route indicated by the arrows; enters the upper part of the generator and first traverses a stratum of fuel that is too damp to take fire at the moment of charging; carries along the gas of distillation that the high temperature of the generator forms in this first stratum; and, thus charged, reaches a hotter stratum, where the distilled wood is burned. In traversing this highly heated zone, the gas of distillation burns or is transformed, and the entire mass, continuing its downward motion, traverses a third stratum of fuel which is red-hot charcoal, the temperature of which decreases downwardly. The reaction that is capable of taking place in this zone is merely the reduction of the carbonic acid to carbonic oxide and hydrogen under the influence of the red-hot wood coke.

As these reactions are endothermic, they cool the mass; so the lower strata become cooler and cooler and are composed especially of ashes. The gas thus makes its exit from the bottom of the generator at the very reduced temperature of about 300 deg. This ingenious arrangement might present two inconveniences, which, however, could be easily remedied. One would be that the fuel that has escaped combustion at the top of the generator might not complete the combustion at the bottom, where the temperature is higher and the gases are reducing ones. Quite a large part of the fuel would therefore be lost with the ashes; and this is confirmed by experience.

Moreover, the inconvenience seems to be so grave that it has, up to the present, prevented the use of gas generators with reversed combustion recommended by many engineers as the best solution of the question of the purification of gas. With wood, such an inconvenience can be easily compensated for. This is, in effect, because it is very easy to separate the charcoal from the wood ashes, either by sifting or by precipitating the whole into water, in which the charcoal will float upon the surface. The other inconvenience of the motion of the gas downwardly is that the latter carries along a large quantity of ashes, and it is thus impossible to employ it until after it has been scrubbed.

In the apparatus herewith figured, the filtering is done in the annular tubulure, *n*, a sort of scrubber in which a column of coke is arranged and from which the gas afterward goes to a purifier, *o*, and thence to the gasometer.

This scrubber serves at the same time for the heating of the primary air, the inlet pipe, *i i*, of which traverses the heated coke. This air afterward bubbles up, at *j*, through water supplied by a cock, *s*, before reaching the gas generator.

In the figure may be seen, too, an ingenious arrangement for the disposal of the ashes, which are collected in a conduit. At *e* may be seen a section of this, and at *f* a device for removing the ashes. This apparatus, which consists of a half-disk mounted upon a

CRANE WEIGHING MACHINE, GLASGOW EXHIBITION.

rod, when introduced by pressure into the mass of ashes and revolved, stirs up the latter, and pulls a portion into the box, *g*, which is closed by a hydraulic joint.

A new gas generator in course of construction at the same works will differ from the first in that the ashes will be received upon an inclined grate, whence they will be projected into the ash box by fingers passing through the grate bars and mounted upon an axis parallel with the plane of the latter, at right angles with the line of the greatest slope, and forming a sort of rotary comb. This gas generator will be charged every three-quarters of an hour.

It suffices, in either case, to collect the charcoal dispersed through the ashes and representing a little more than 10 per cent of the weight of the wood used for charging. This charcoal may be employed for any sort of use, since it is a very good fuel and very dense, although the pieces have not the proper shape for sale. So, in case there were no local use for it, it would be well to introduce it anew into the generator with subsequent charges of wood. One of the great advantages of the apparatus is that, apart from the scrubber, there is no purifier, and that the motors that are employed operate perfectly without presenting any of the accidents that are so frequent with the use of fuels other than coke or anthracite.

There are no acetylenic carburets, such as are observed in wood gas, even after it has traversed red-hot coke in reversed distillation.

It must be remarked, too, that the operation is exceedingly simple. In gas generators, as a general thing, one's whole attention must be paid to the lower part, where the combustion takes place near the grates. Even in the best apparatus, it is difficult to protect the grates against the fire, and the masonry of the furnace and boshes lasts but a short time, and the bricks fuse. In gas generators with reversed combustion, on the contrary, the base of the apparatus is relatively cold. The cleaning is done with the greatest ease, and no deterioration of the grates and masonry need be apprehended; so it would seem as if the cost of maintenance ought to be nil. There need be no fear, even, of very high temperatures at the top of the apparatus, where the fresh fuel and the entrance of air at a relatively low temperature prevent an abnormal heating.

It must be observed that, in such a gas generator, it is possible to employ any kind of wood in any form whatever. All kinds of waste of the least value may be used, and stumps, knotty wood and the refuse of sawmills may be burned. It is possible to employ wood that has been cut but three months and to modify the operation of the generator according to the rapidity of the charging and cleaning.

We give herewith a few analyses. With green wood, cut two or three months previously, the following gases have been obtained:

IN VOLUME.

Carbonic acid	10.00	10.30	10.60
Carbonic oxide	18.50	18.00	16.70
Methane	0.70	0.10	1.40
Hydrogen	17.40	18.30	17.70
Nitrogen	53.40	53.30	53.60
	100.00	100.00	100.00
Calorific power per cubic foot at 15 deg. in heat units	30	28	30.8

From richer gas obtained from air-dried wood, cut from four to six months, there has been obtained:

IN VOLUME.

Carbonic acid	10.70	9.40	9.20	12.50
Carbonic oxide	17.90	21.20	22.80	19.70
Methane	3.10	2.40	1.30	2.80
Hydrogen	17.60	15.80	17.40	15.00
Nitrogen	50.70	51.20	49.30	50.00
	100.00	100.00	100.00	100.00
Calorific power per cubic foot at 15 deg. in heat units	36.2	35.7	35.4	35.6

Finally, by modifying the operation of the generator, it has been possible to obtain gas richer in methane, that is to say, in which the products of distillation are not so completely decomposed.

IN VOLUME.

Carbonic acid	15.20	13.50	16.80
Carbonic oxide	15.40	9.70	14.20
Methane	7.20	12.30	8.80
Hydrogen	12.60	14.90	14.00
Nitrogen	49.60	49.60	46.20
	100.00	100.00	100.00
Calorific power per cubic foot at 15 deg. in heat units	41.25	51.4	45.5

Such gas differs from that of coke and anthracite in that the proportion is higher with respect to that of the carbonic oxide. This seems to show that the temperature of the zone of combustion is not very high.

This gas generator with reverse combustion is therefore an extremely practical apparatus of unexampled simplicity, which in many regions ought, with gas motors, to afford motive power at very advantageous figures.—J. Deschamps, in Le Genie Civil.

ENAMELING.—V.

FUEL.

THE consumption of fuel in an enameling factory is the most serious item of the expenditure. Ill-constructed or badly proportioned stoves may represent any loss of coal from a quarter to one ton per day, and as great and uniform temperatures must be maintained, fuel of low quality and price is not desirable. In the melting stoves either arranged as tank or crucible furnaces, the character of the coal must not be neglected, as light dust, iron oxide or injurious gases will enter into the crucibles through any opening, especially if the draught is not very great. Almost any of the various kinds of fuel may be used, provided that the system of combustion is specially arranged for in the construction of the furnaces. Charcoal is one of the best fuels available, its calorific value being so great; but its cost is in some places almost prohibitive. Wood burns too quickly, and is therefore expensive, and necessitates incessant firing.

For practical purposes we are thus often left to a selection of some type of coal. A coal with comparatively little heating power at a cheap price will be found more expensive in the end than one costing more, but capable of more rapid combustion and possessing more heat-yielding gases. Cheap and hard coals give the fireman an amount of labor which is excessive. He becomes irritable and discontented, and the proper maintenance of the temperature of the stove is almost impossible. Anthracite is excellent in every way, as it consists of nearly pure carbon, giving off a high degree of heat without smoke. Its use, of course, necessitates the use of a blower, but to this there can be no objection. Any coal which will burn freely and clean, giving off no excessive smoke, and

FIG. 9.—GRINDING MILL.

capable of almost complete combustion, will give satisfaction in enameling; but it must not be forgotten that the consumption of fuel is so large that both price and quality must be carefully considered. Experimental tests must be made from time to time. A cheap, common coal will never give good results, and a good expensive coal will make the cost of manufacture so great that the prices of the enameled articles will render them unsalable. Any ordinary small factory will use from two to four tons per day of coal, and it will thus be seen that the financial success of a concern lies to a very great extent at the mouth of the furnace. Coke is a good medium for obtaining the necessary heat required in enameling if it can be got at a reasonable price. With a good draught a uniform temperature can be easily kept up, and the use of this by-product is, therefore, to be recommended.

With good coal and a furnace constructed to utilize the heat given off to the fullest extent, there may still be unnecessary waste. The arrangement of the bars should only be made by those who fully understand the character of the coal and the objects in view. The fireman in charge should be thoroughly experienced and reliable, as much waste is frequently traced to imperfect feeding of the fuel. At one concern in England two furnaces were attended to by separate men. The construction, capacity, and class of fuel used were all alike; but in one the consumption of coal varied from 15 to 20 per cent in excess of the other. On the men being changed over, the reduction in fuel consumption was transferred to the other furnace, thus clearly demonstrating the difference between the two attendants, and the importance which should be attached to the so-called simple performance

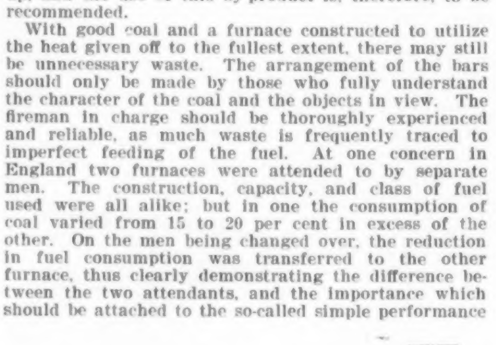


FIG. 10.—GLAZING MILL.

of firing. Another system by which fuel is very frequently wasted is by only having small charges of plates in the fusing oven at a time, or by allowing too long a period between each charge. Before the furnace has been raised to its working temperature every article which is possible to get ready should be coated and in the drying stove. Each charge of articles should be as large as possible, as fusing will take place equally as well on many articles as on few. The charges should follow one another as rapidly as can be conveniently carried out; and where this is not done there is a lack of organization which should be immediately remedied.

Mills.—Any hard substances must first be broken up and pounded in a pounding or stamping mill, or in any other suitable manner, thus reducing the lumps to a granular condition. When this has been done, the coarse is separated from the fine parts and the former again operated on. The next process is roller grinding for reducing the hard fritted granular particles to a fine powder. These mills vary in construction, but a satisfactory type is shown in Fig. 9. Motion is conveyed by a belt to the driving pulley, and this is transmitted from the pinion to the large bevel, which is connected by a shaft to the ground plate. As this revolves, the material causes the mill-wheels to revolve, and in this way the material is reduced to a powder. The rollers are of reduced diameter on the inner side to prevent slippage, and when all the parts are made of iron, the metal must be close grained and of very hard structure, so as to reduce the amount removed by wear to a minimum. When the materials are ground wet, the powder should be carefully protected from dust and thoroughly dried before passing to the next operation.

The glazing or enamel mills are shown in Fig. 10. These mills consist of a strong iron frame securely bolted to a stone foundation. In the sketch shown the framing carries two mills, but three or four can be arranged for. A common arrangement for small factories consists of two large mills, and one smaller mill, driven from the same shaft. One of the mills is used for foundation or gray mixings, the second for white, and the smallest one for colored mixings. In these mills it is essential that the construction is such as to prevent any iron fitting coming into contact with the mixing, for, as has already been explained, the iron will cause discoloration. The ground plate is composed of quartz, and is immovable. It is surrounded by a wooden casing—as shown at *a*—and bound together by iron hoops. The millstones are heavy, rectangular blocks of quartz, called "French burr stone," and into the center the spindle, *b*, is led. The powdered material mixed with about three times its bulk of water, is poured into the vats, *a*, and the grinding stones are then set in motion. When a condition ready for enameling has been reached the mixture is run off through the valves, *c*. Each mill can be thrown out of gear when required, by means of a clutch box, without interfering with the working of the others. The grinding stones wear rapidly and require to be refaced from time to time. To avoid stoppage of the work therefore, it is advisable to always have a spare set in readiness to replace those removed for refacing. The composition of the stones should not be neglected for, in many cases, faults in the enamel have been traced to the wearing away of stones containing earthy or metallic matter.

Enamel Mixing.—All constituents of which an enamel glaze is composed must be intimately mixed together. This can only be done by reducing each to a fine powder and thoroughly stirring them up together. In English factories this part of the work is often carried out in a very superficial manner, one material showing much larger lumps than another. Under circumstances such as these it is absurd to imagine that in fusion equal distribution will take place. What really happens is that some parts of the mass are insufficiently supplied with certain properties while others have too much. A mixture of this class can only produce unsatisfactory results in every respect, for the variations referred to will produce variations in the completeness of fusion in the viscous character of the mass, and in the color.

The mixing can be done by thoroughly stirring the various ingredients together, and a much better and cheaper system is mixing in rotating barrels or churns. These are mounted on axles which rest in bearings, one axle being long enough to carry a pulley. From the driving shaft a belt is led to the cask, which then rotates at a speed of from forty to sixty revolutions per minute, and in about a quarter of an hour the operation is complete. The cask should not exceed the five-gallon size, and should at no time be more than two-thirds full. Two casks of this kind give better results than one twice the size. The materials are shot into the cask in their correct proportions through a large bung hole which is then closed over by a close-fitting lid.

Mixings.—For gray or fundamental coatings:

		Per Cent.
(1)	Almost any kind of glass	49
	Oxide of lead	47
	Fused borax	4
(2)	Glass (any kind)	61
	Red lead	22
	Borax	16
	Niter	1
(3)	Quartz	67.5
	Borax	29.5
	Soda (enameling)	3

The above is specially adapted for iron pipes.

(4)	Frit of silica powder	60
	Borax	33
	White lead	7

Fused and then ground with—
Three-tenths weight of silica frit,
Clay, three-tenths of silica frit,
Magnesia, one-sixth weight of white lead.

(5)	Silica	65
	Borax	14
	Oxide of lead	4
	Clay	15
	Magnesia	2

No. 5 gives a fair average of several mixings which are in use, but it can be varied slightly to suit different conditions of work.

Defects in the Gray or Ground Coating.—Chipping is the most disastrous. This may be prevented by the addition of some bittersalt, say from 3 to 4 per cent of the weight of the frit.

The addition of magnesia when it has been omitted from the frit may also act as a preventive, but it should only be added in very small quantities, not exceeding 2.5 per cent, otherwise the temperature required for fusion will be very great.

Coating and Fusion.—Difficulties of either may generally be done away with by reducing the magnesia used in the frit to a minimum.

A soft surface is always the outcome of a mixing which can be fused at a low temperature. It is due to too much lead or an insufficiency of clay or silica powder.

A hard surface is due to the quantity of lead in the

mixing being too small. Increase the quantity and introduce potash, say about 2.5 per cent.

The gray or fundamental mixing should be kept together in a condition only just sufficiently liquid to allow of being poured out. When required to be applied to the plate, the water necessary to lower it to the consistency of thick cream can then be added gradually, energetic stirring of the mass taking place simultaneously in order to obtain uniform distribution.

The time required for fusion may vary from 15 minutes to 25 minutes, but should never exceed the latter. If it does, it shows that the mixing is too viscous, and the remedy would be the addition and thorough intermixture of calcined borax or boracic acid. Should this fail, then remelting or a new frit is necessary.

A highly-glazed surface on leaving the muffle shows that the composition is too fluid and requires the addition of clay, glass, silica powder or other substance to increase the viscosity.

As has been already explained, the glaze is much more important than the fundamental coating. Discoloration or slight flaws which could be tolerated in the latter would be fatal to the former.

In glazes, oxide of lead need not be used. It should never be used in a coating for vessels which are to contain acids or be used as cooking utensils. It may be used in sign tablet production.

For pipes the following glaze gives good results:

	Per Cent.
(1) Feldspar	33
Borax	22.5
Quartz	16.5
Oxide of tin	15
Soda	8
Fluorspar	3.75
Saltpeter	2.25

For sign tablets the following gives fair results, although some of the succeeding ones are in more general use.

	Per Cent.
(2) Cullet	20
Powdered flint	15
Lead	52
Soda	4.5
Arsenic	4.5
Niter	4
(3) Frit of silica powder	30
Oxide of tin	18
Borax	17
Soda	8.6
Niter	7.5
White lead	5.5
Carbonate of ammonia	5.5
Magnesia	4
Silica powder	4

The following are useful for culinary utensils, as they do not contain lead:

	Per Cent.
(4) Frit of silica powder	26
Oxide of tin	21
Borax	20
Soda	10.25
Niter	7
Carbonate of ammonia	5
Magnesia	3.25

This should be ground up with the following:

	Per Cent.
Silica powder	4.25
Oxide of tin	2.25
Soda	0.5
Magnesia	0.5
(5) Feldspar	41
Borax	35
Oxide of tin	17
Niter	7
(6) Borax	30
Feldspar	22
Silicate powder	17.5
Oxide of tin	15
Soda	13.5
Niter	2

Borax will assist fusion. Quartz mixings require more soda than feldspar mixings.

	Per Cent.
(7) Borax	28
Oxide of tin	19.5
Cullet (powdered white glass)	18
Silica powder	17.5
Niter	9.5
Magnesia	5
Clay	2.5
(8) Borax	26.75
Cullet	19
Silica powder	18.5
Oxide of tin	19
Niter	9.25
Magnesia	4.5
Soda	3

To No. 7 must be added—while being ground—the following percentages of the weight of the frit:

	Per Cent.
Silica powder	18
Borax	9
Magnesia	5.25
Boracic acid	1.5

To No. 8 should be similarly added the following percentages of the frit:

	Per Cent.
Silica powder	1.75
Magnesia	1.75
Soda	1

This mixing is one which is used in the production of some of the best types of hollow-ware for culinary purposes. The glaze should be kept in tubs mixed with water until used, and it should be carefully protected from dust.

Defects in the Glaze or White.—A bad white may be due to its being insufficiently opaque. More oxide of tin is required. Cracks may be prevented by the addition of carbonate of ammonia. Insufficient luster can be avoided by adding to the quantity of soda and reducing the borax. If the gray shows through the white it proves that the temperature of fusion is too high or the viscosity of the mixing is too great. If the coating is not uniformly spread it may be due to the glaze being too thin; add magnesia. If the glaze separates from the gray add some bittersalt. Viscosity will be increased by reducing the quantity of borax. Immunity against chemical reaction is procured by increasing the quantity of borax. An improved luster will be obtained by adding native carbonate of soda. The greater the quantity of salicic acid the greater must be the temperature for fusion. To reduce the temperature add borax. Clay will increase the difficulty of fusion. Oxide of lead will make a frit more easily fusible. A purer white can be obtained by adding a small quantity of smalt.

Water.—The character of the water used in the mixing of enamels is too frequently taken for granted, for unsuitable water may render a mixing almost entirely useless. Clean water, and with little or no sulphur present, is essential. For very fine enamels it is advisable to use carefully filtered water which has shown, after analysis, that it is free from any matter which is injurious to any of the enamel constituents.

How to Tell the Character of Enamel.—In the case of sign tablets the characteristics looked to are appearance and the adherence of the coatings to the iron. For the latter the tests are simple. The plate if slightly bent should not crack the coating. An enamel plate placed in boiling water for some time and then plunged into very cold water should not show any cracks, however small, even after repeated treatment of this kind.

Culinary utensils, and those to hold chemicals, should not only look well, but should be capable of resisting the action of acids. Lead should never enter into the composition of enamels of this class, as they then become easily acted upon, and in the case of chipping present a menace to health. The presence of lead is easily detected. Destroy the outside coating of the enamel at some spot by the application of strong nitric acid. Wash the part and apply a drop of ammonium sulphide. If lead is present, the part will become almost black, but remains unchanged in color if it is absent.

Another simple test is to switch up an egg in a vessel and allow it to stand for about twenty-four hours. When poured out and rinsed with water a dark stain will remain if lead is present in the enamel. To test the power of chemical resistance is equally simple. Boil diluted vinegar in the vessel for several minutes, and if a sediment is formed and the luster and smoothness of the glaze destroyed or partially destroyed, it follows that it is incapable of resisting the attacks of acids for any length of time. There are several other tests adopted, but those given present little difficulty in carrying out, and give reliable results.

Wasters and Seconds: Repairing Old Articles.—In all enameling there must be certain articles turned out which are defective, but the percentage should never be very great. The causes which most frequently tend to the production of wasters are new mixings and a temperature of fusion which is either too high or too low. There are two ways of disposing of defective articles, viz.: (1) Chipping off the bad spots, patching them up and selling them as "seconds"; (2) throwing the articles into the waste heap. The best firms adopt the latter course, because the re-coating and firing of defective parts practically means a repetition of the whole process, thus adding greatly to the cost, while the selling price is reduced. Overheating in fusion is generally shown by blisters or by the enamel being too thin in various places. Chipping may be also due to this cause, the excessive heat having practically fused the fundamental coating.

At this stage the defects may be remedied by breaking off the faulty parts, patching them up, and then recoating the whole. With sign tablets there is no objection to doing so, but with hollow-ware the fact remains that the article is faulty, no matter how carefully defects may be hidden. As white is the most general coating used, and shows up the defects more than the colored coatings, the greatest care is necessary at every stage of the manufacture. While glowing on the article, it should appear uniformly yellow, but on cooling it should revert to a pure white shade. On examining different makes of white coated articles, it will be found that some are more opaque than others. The former are less durable than the latter, because they contain a large percentage of oxide of tin, which reduces the elasticity. To ensure hardness the mixing must be very liquid, and this cannot be arrived at when a large quantity of oxide of tin is introduced.

Old utensils which have become broken or chipped can be repaired, although, except in the case of large articles this is rarely done. The operations necessary are: (1) The defective parts chipped off; (2) submitted to a red heat for a few moments; (3) coated with gray on the exposed iron; (4) fused; (5) coated with the glaze on the gray; (6) fused.

PAINTS AND VARNISHES FOR THE PRESERVATION OF METALS AND WOODS.*

CUPRIC SULPHATE (Blue Vitriol).—This is employed in solution, in the proportion of 10 kilogrammes to 1 hectoliter of water.

When completely dissolved, wood is immersed in it for a period of 18 to 36 hours, according to the kind and the size of the pieces. The immersion must be entire during the whole time, and the liquid kept at a suitable level by the addition, as needed, of the sulphate (10 per cent) dissolved in water.

It must not be forgotten that this solution is very poisonous and corrosive. It ought never to be applied to wood that is to be handled; and the operator should wash his hands thoroughly with soap, immediately after using it. All solution left over should be thrown into a trench and covered with earth.

Wood, treated with the sulphate and put under ground, will last thrice as long as wood not treated.

Coal Tar.—Coal or mineral tar, the residue of the manufacture of illuminating gas, is furnished by the gas works at a very low price. Its use can be recommended for the preparation of soft wood, either to be buried or to be left exposed to the atmosphere. It cannot penetrate hard woods; its influence on them is so slight as not to be worth the expense of application, trifling as this may be. It also becomes pitchy and cracks, so it cannot be used for wood that is to be handled.

Tar (vegetable), though much more costly than coal tar, is regarded as preferable. M. Vinart, of Trouville-sur-Mer, in a comparative test on different woods, obtained the same results with one coating of this tar, as with five coatings of coal tar. Not counting the occasional expense of coloring, the cost is really less than with coal tar. It is applied hot, and imparts a fine brown color. It does not conceal the grain of the wood. Unfortunately, it grows pitchy from heat, like coal-tar, and in consequence is not available for all purposes.

Tar Paints.—These paints, called also mineral or metallic paints, are sold in barrels or boxes, at varying prices, between 35 and 45 francs per 100 kilos. Some dealers color them—yellow ocher, red ocher, brown, gray, etc. They are prepared by mixing equal parts of coal-tar and oil of turpentine or mineral essence (gasoline). The product, if it is not colored artificially, is of a brilliant black, even when cold. It dries in a few hours, especially when prepared with oil of turpentine. The paints with mineral essence are, however, generally preferred, on account of their lower cost. Either should be spread on with a hard brush, in coats as thin as possible. They penetrate soft woods, and even semi-hard woods, sufficiently deep, and preserve them completely. They adhere perfectly to metals. Their employment can, therefore, be confidently advised, so far as concerns the preservation directly of iron cables, reservoirs, the interior surface of generators, etc. However, it has been shown that atmospheric influence or variations of temperature cause the formation of ammoniacal solutions, which corrode the metals. Several companies for the care and insurance of steam engines have for some time recommended the abandonment of tar products for applications of this kind and the substitution of hot linseed oil.

Coal-tar Paints.—These are prepared accordingly to various formulas. One in current use has coal-tar for a base, with the addition of gum-resin. It is very black. Two thin coats give a fine brilliancy. It is employed on metals, iron, sheet iron, etc., as well as on wood. It dries much quicker than the tars used separately. Its preserving influence against rust is very strong.

The following Tissandier formula has afforded excellent results. Its facility of preparation and its low cost are among its advantages. Mix 10 liters of coal-tar, 1 to 1.6 kilo of slaked lime, 40 centiliters of oil of turpentine, and 4 centiliters of strong vinegar, in which 200 grammes of cupric sulphate has been previously boiled. The addition of 2 or 3 cloves of garlic in the solution of cupric sulphate aids in producing a varnish, brilliant as well as permanent. The compound can be colored like ordinary paints.

Carbonyle.—This is an oil of quite complex composition, consisting of tar, resinous oil or naphtha, oil of turpentine, different hydrocarbons, cupric sulphate, etc. Its employment can be recommended, not only because it assures, at low cost, the preservation of the wood, whether to be used under ground or exposed to atmospheric changes, but because it possesses disinfecting properties. It is used for sprinkling racks, mangers, stalls and stables, as well as for the disinfection of harness. Its handling and application are easy and free from danger. On contact, the wood takes a good brown color, permanent, without concealing the grain of the wood.

Rectified Resinous Oil for Painting.—This product must not be confounded with oils used in the preparation of lubricants for metallic surfaces exposed to friction. It contains a certain quantity of resin in solution, which, on drying, fills the pores of the wood completely, and prevents decomposition from the action of various saprophytic fungi. It is well adapted to the preservation of pieces to be buried in the ground or exposed to the inclemency of the weather. Paints can also be prepared with it by the addition of coloring powders, yellow, brown, red, green, blue, etc., in the proportion of 1 kilo to 5 liters of oil. The addition ought to take place slowly, while shaking, in order to obtain quite a homogeneous mixture. Paints of this kind are economical, in consequence of the low price of resin (35 francs per 100 kilogrammes in casks), but they cannot be used in the interior of dwellings by reason of the strong and disagreeable odor disengaged, even a long time after their application. As an offset, they can be used like tar and carbonyle, for stalls, stables, etc.

Oil and Turpentine Paints.—These are the only ones suitable for the interior of dwellings, and for the preservation of certain wooden appliances, as threshing implements, etc.

Iron Paint.—This product, recommended by Tissandier, is composed of linseed oil varnish, holding in suspension a proportion of very fine iron filings, varying according to the object to be attained. It is of current use in Germany, for wood, stone or iron, for a great variety of purposes, particularly on walls and objects exposed to moisture. For iron, ordinary cleaning is sufficient, without great previous care in the removal of rust and grease.

* Translated from the French of M. J. Troude, Professor of the National Agricultural School at Douai, in the Agriculture Nouvelle.

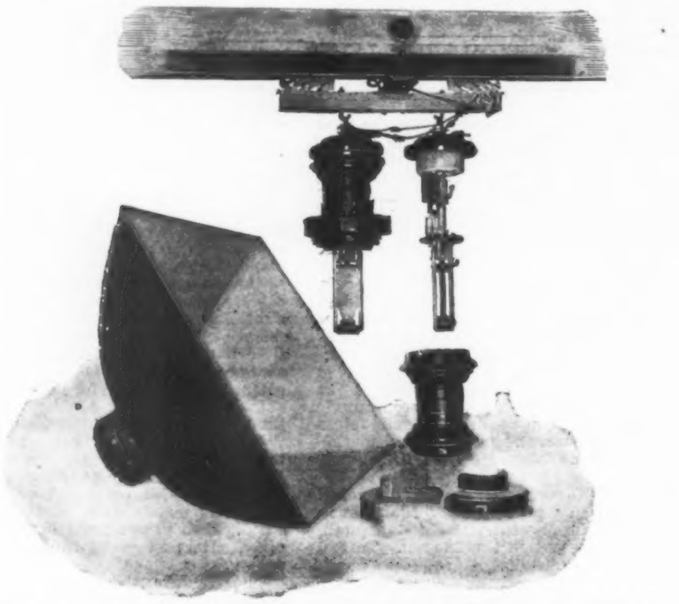
Fusible Alloys for Electric Installations.—These alloys are employed in electric installations as current interrupters. Serving as conductors on a feeble length of circuit, they melt as soon as the current becomes too strong. Following is the composition of some of these alloys as published in the Elektrotechnische Zeitschrift:

Fusing temperature.	Lead.	Tin.	Bismuth.	Cadmium.
95.0 deg. Cent.	250	500	500	—
89.5 " "	297	—	532	71
76.5 " "	344	94	500	62
68.5 " "	260	148	522	70
65.8 " "	249	142	561	108
63.0 " "	267	133	500	100

These alloys are prepared by melting the lead in a stearine bath and adding successively, and during the cooling, first, the cadmium; second, the bismuth; third, the tin. It is absolutely necessary to proceed in this manner, since these metals fuse at temperatures ranging from 325 deg. (for lead) to 230 deg. (for tin).

ARC LAMPS FOR BLUE PRINTING.

The development of the arc lamp has been of immense benefit to industry in that it has made the manufacturer almost independent of natural illumination. In textile mills, the recently perfected inclosed arc lamp furnishes a light almost, if not quite, equal to daylight and enables the mill to be operated twenty-four hours a day, if necessary, without detriment to the product. More recently, the processes of photography, which have heretofore been regarded as entirely dependent upon the sun's light, have been accomplished with equal perfection by the same inclosed arc lamp. The importance of this application of electricity will be immediately appreciated in all factories and machine shops where blue prints are followed in the construction of machinery or issued for the information of constructing engineers and purchasers.

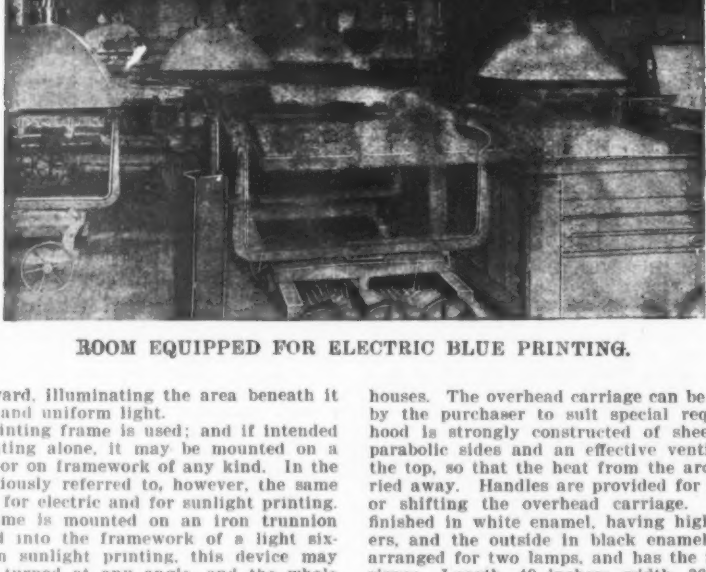


ARC LAMPS AND HOOD SHOWING USUAL METHOD OF SUPPORT.

The accompanying illustrations show an installation of arc lamps in the blue print department of a manufacturing plant which uses annually half a million blue prints.

The lamps are the standard 5 ampere design manufactured by the General Electric Company. They burn in multiple on 110 volt direct current circuits with 80 volts at the arc. While this form of lamp is used in the installation illustrated, equally good results may be accomplished with the General Electric Company's 7½ ampere alternating current lamp or with the 220 volt power circuit lamp. The latter lamp would naturally be selected for factories where direct current motors operating on 220 volt circuits are used to drive the machines.

The lamps are furnished with light opal inclosing globes and mounted in pairs on a small carriage which may be run back and forth on a beam attached to the ceiling. Over the lamps, a sheet iron hood with a white interior is arranged to reflect practically all of the light downward, illuminating the area beneath it with a brilliant and uniform light.



ROOM EQUIPPED FOR ELECTRIC BLUE PRINTING.

A standard printing frame is used; and if intended for electric printing alone, it may be mounted on a stationary table or on framework of any kind. In the installation previously referred to, however, the same frames are used for electric and for sunlight printing. The wooden frame is mounted on an iron trunnion which is pivoted into the framework of a light six-wheel truck. In sunlight printing, this device may conveniently be turned at any angle, and the whole frame may be easily removed to a room for refilling. When printing by arc lamps, the truck remains stationary and the frame is permanently placed in a horizontal position directly beneath the lamps and reflector. One or two other frames similarly mounted are arranged under the ceiling beam in line with the first. Having arranged the tracing and blue print paper in one of these frames, the lamps are placed over it by moving them along the beam. In the meantime, one of the other frames is being prepared. When the first print has been sufficiently exposed, the lamps are moved over the second frame and so on through a long row, or back and forth between two frames, as required by the demand for prints and the facilities for getting the frames ready.

The time required to make a print with the electric equipment just described naturally varies widely with different tracings and different makes of paper. In general, it may be stated that the time required is three or four times longer than with bright sunlight. For example, in one manufacturing plant where prints are usually made by bright sunlight in forty-five seconds, the time required with the electric equipment is from one to three minutes.

The intelligent manufacturer will see at a glance the advantages of a blue print equipment which is independent of sunlight and weather conditions. With the electric equipment, blue prints may be put into the factory almost immediately on the completion of the tracings regardless of the time of day or atmospheric conditions. During the short days of the winter season, the blue print works need not necessarily suffer; for when the sunlight fails, work may be continued under the electric lamps. The electric method will also appeal to manufacturers located in crowded cities where tall buildings exclude the rays of the sun during all or a part of the day.

EQUIPMENT.

The General Electric Company is prepared to furnish lamps for blue printing equipments for direct or alternating current. The blue printing frames and trucks can be secured from manufacturers or supply houses. The overhead carriage can be readily made up by the purchaser to suit special requirements. The hood is strongly constructed of sheet iron, and has parabolic sides and an effective ventilating device at the top, so that the heat from the arcs is rapidly carried away. Handles are provided for lifting the hood, or shifting the overhead carriage. The interior is finished in white enamel, having high reflecting powers, and the outside in black enamel. Each hood is arranged for two lamps, and has the following dimensions: Length, 48 inches; width, 36 inches; height, 19 inches.

All of these lamps are simple in construction and thousands of them are operating in locations where they do not admit of attention or adjustment more than once in several days.

Care should be taken to see that the voltage at the arc is as high as specified in each case, as otherwise the time required to make prints will be considerably increased.

CONTEMPORARY ELECTRICAL SCIENCE.*

Thermo-magnetic Properties of Bismuth.—L. Lownds has measured the thermo-magnetic constants of bismuth within limits of temperature and field strength considerably exceeding those attained by Van Everdingen, Yamaguchi and other previous observers. He used a plate of crystalline bismuth cut from a large crystal so that the chief crystallographic axis lay in the plane of the plate and parallel to its length. For the longitudinal thermo-magnetic effect the highest percentage change of thermo-electric force was 8.54, obtained with a field of 6,100 units, with the crystallographic axis normal to the lines of force and parallel to the current of heat. With the crystallographic axis normal also to the heat current, the corresponding value was —3.50, and with the axis parallel to the lines of force and normal to the heat current the effect was 0.97 per cent at 4,400 units. As regards the transverse thermo-magnetic effect, the author found for low temperatures (—130 deg.) and large field strengths a diminution of the effect, whereas Yamaguchi found a continuous increase with falling temperature in electrolytic bismuth. The author also studied the thermo-electric force displayed by bismuth in various directions, and found that parallel to the axis it was 1.91 times as strong as normal to the axis. Perrot found 2.0 for the same ratio.—L. Lownds, Phil. Mag., October, 1901.

Glass Cutting.—All glass-cutting processes are good when carried out by good operators; but some processes are more certain in their working than others. G. Roy recommends the use of the thermal cauterizer, which has given satisfaction in the laboratory of Dijon University for the last three years. Instead of using the Berzelius carbon, or a hot copper wire, the author uses a "thermo cautère" in conjunction with an enameling blast. To cut a tube a crack is made by means of a light blow. The instrument is heated and placed lightly in advance of the crack, and the latter at once extends in the direction thus marked. The operation succeeds the better after the course of the crack has been marked out with a diamond. The crack obeys with such precision that it can be made nearly to turn a right angle. It is thus possible to cut a tube in any direction, or to take the bottom out of a flask, or to prepare a spherical vessel with any aperture. In this connection it should be remembered that Dvorak makes glass sieves by puncturing a glass globe with a red hot arc carbon, touching the surface lightly with it. These sieves have been kept for months without cracks appearing in them.—G. Roy, Journ. de Phys., October, 1901.

EQUIPMENT FOR ELECTRIC BLUE PRINTING.

Effect of Illumination Upon Metallic Surfaces.—When a metallic plate is illuminated by ultra-violet light it easily loses a negative charge, but this loss is not maintained at the same rate on prolonging the illumination while maintaining the potential. The discharging power of the ultra-violet rays seems to exhaust itself. After a prolonged exposure the plate is no longer sensitive, and requires keeping in the dark for some time before showing any photo-electric effect; or the action can be restored by renewing the surface, as is done easily in the case of amalgamated zinc by simply wiping it. M. Buisson, who has paid special attention to this matter, notices that it is connected with other physical properties of metals, notably the difference of potential established on contact. The illuminated metal becomes more strongly negative. But, again, this modification is not permanent, and it rapidly disappears in the dark. The effect is independent of the gas surrounding the metals. Various photographic facts also show analogies, notably the fact that

*Compiled by E. E. Fournier d'Albe in The Electrician.

an exposed plate cannot be developed after long storage in the dark. The modification of metallic surfaces only affects an extremely thin surface layer, and exerts no influence upon optical polarization. It is due, according to the author's opinion, to condensed or occluded gas or vapor.—M. Buisson, Journ. de Physique, October, 1901.

SUSCEPTIBILITY OF FERRIC CHLORIDE.—The susceptibility of magnetic salts in solution is of interest as illustrating the effect of physical state and chemical combination upon the magnetic properties of an element. Jaeger and Meyer studied the temperature coefficient of the magnetic susceptibility of iron and nickel salts, and found the coefficients to vary between —0.00219 and —0.00305. Plessner, on the other hand, found pretty uniform values of —0.00356 for all salts and concentrations. H. Mosler, who has just completed some new measurements, finds that the former values are the more correct, but there is a strong variation with the degree of concentration. A 10.3 per cent solution of ferric chloride has a temperature coefficient of 0.00268. At 28 per cent there is a sudden increase, and at 33.1 per cent a maximum of 0.00358 is attained. The original value is regained at a concentration of 41 per cent. The author has vainly endeavored to bring this irregularity into touch with other physical properties of the same solution, such as conductivity or freezing point. The other magnetic metals show slight and irregular variations. Plessner's method of suspending a glass bulb torsionally in the magnetic field was used.—H. Mosler, Ann. der Physik, No. 9, 1901.

MAGNETIZATION AND MODULUS OF ELASTICITY.—Relations between magnetization and extension and between magnetization and torsion have been the subject of careful and fruitful researches. Those between the longitudinal elasticity and the magnetization have hitherto not been satisfactorily dealt with owing to the smallness of the effect. K. Tangl's recent experiments do something to furnish us with consistent data. If a wire is magnetized under constant tension it changes its length. But if it is magnetized in such a manner that its length remains constant the tension varies. The ratio between the two alterations is proportional to the modulus of elasticity under the magnetization applied. This is the principle of the author's measurements. The results go to show that magnetization increases the modulus, as against the neutral results of Wertheim and Tomlinson. The change is about 3 per cent in iron for a field of a few hundred units, and about 1.5 per cent for nickel. As regards the extension under magnetization, Bidwell has already observed that the effect of loading is very much greater in nickel than in iron. This is all the more remarkable as the influence of loading in changing the modulus is greater in iron than in nickel.—K. Tangl, Ann. der Physik, No. 9, 1901.

PLATINUM RESISTANCES.—The acquisition by the Reichsanstalt of a Linde apparatus for liquefying air has led to a new series of low-temperature researches which comprise a comparison of the hydrogen, platinum, and petroleum-ether thermometers. As regards the platinum-resistance thermometers, of which five were tested, the discrepancies were of the order of 1-100th of a degree, the greatest deviation being shown by one of the Cambridge wires, which showed a negative correction of 0.11 deg. The temperature coefficients between 0 deg. and 100 deg. varied from 0.003792 to 0.002910. One of the wires showed a secular decrease of 1-50th per cent. To obtain a fixed point for testing platinum thermometers, the boiling point of oxygen was redetermined, and found to be —182.79 at 760 mm. pressure. In constructing petroleum-ether thermometers the author endeavored to obtain a liquid which, while it would remain liquid at the boiling point of air, would be less viscous than the commercial article. He obtained by fractional distillation a petroleum-ether with a boiling point of 20 deg. A thermometer containing it will indicate temperatures between —193 deg. and —79 deg. within 2 deg.—L. Holborn, Ann. der Physik, No. 10, 1901.

POINT DISCHARGES.—F. Tamm attempts to answer the question: In what manner does the amount of electricity discharged by a point maintained at a certain potential depend upon the moisture and pressure of the surrounding air? In all such questions the "minimum potential" M is of great importance. Roentgen arrived at it by increasing the potential of a point mounted opposite a plate until discharge set in, and then diminishing the potential to the point at which the discharge stopped. The potential then read was the minimum potential. The author found that this minimum potential remained the same if arrived at from much higher initial values, but that it was somewhat lowered by prolonged discharge, owing to the ionization of the air. The influence of moisture is very straight until the percentage reaches over 50, when the retarding effect of the moisture begins to make itself decidedly felt. As regards the pressure, the author found the following formula, giving the connection between the quantity, e_x, discharged at the low pressure x cm. of mercury, and the quantity e_{76} at normal pressure:

$$e_x = e_{76}\left[\frac{76}{x} - \sqrt{\frac{V}{10^5}} \log \text{nat} \left(\frac{76}{x}\right)\right]^2$$

—F. Tamm, Ann. der Physik, No. 10, 1901.

PHOTOMETRY OF ULTRA-VIOLET LIGHT.—Since the photo-electric effect shows a great increase of intensity in the neighborhood of the sparking potential, it suggests itself to employ this circumstance for the photometry of ultra-violet light. The only difficulty lies in the doubt as to whether, at the stage in question, the photo-electric effect is proportional to the intensity of illumination. H. Kreusler answers this question in the negative, and is therefore obliged to employ a very sensitive apparatus and a potential somewhat inferior to the spark potential. As electrodes he employed various metals, but always aluminium as a negative pole, since only thus a steady light could be secured. The photo-electric cell contained an anode formed of two parallel platinum wires and a cathode of platinum whose distance from the anode could be adjusted by a micrometer screw, thus securing a large range of sensitiveness. The cell contained hydrogen at a low pressure. Measurements were made to determine the absorption of various bodies for ultra-violet light. NO showed a sudden increase of absorption at a wave-length of 250 $\mu\mu$ and water at 200 μ. At 220 $\mu\mu$ the coefficients of absorption for water and NO were 0.007 and 0.095 respectively. But the author suspects that the water contained some glass in solution.—H. Kreusler, Ann. der Physik, No. 10, 1901.

THE PITTSBURG FIRE DEPARTMENT AT WORK.

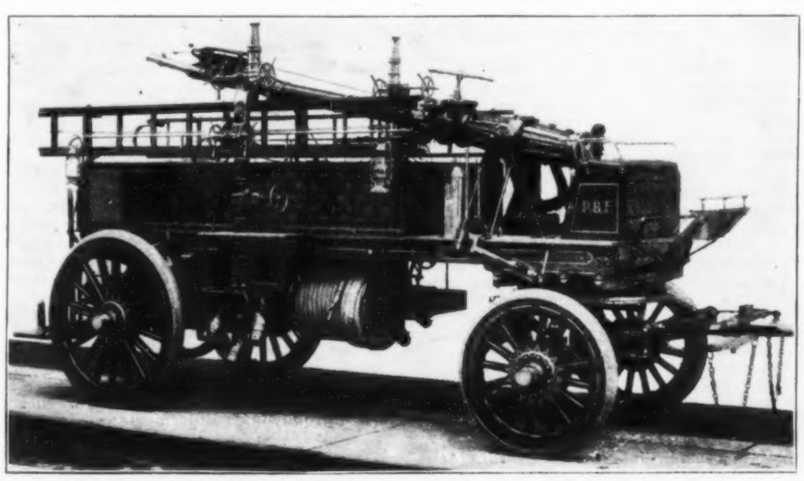
THE reputation of the fire department of New York city as being the finest in the world, or in this country at least, is so well established in the minds of many people that they lose sight of the fact that there are other departments of fire that are the equal, and, in many respects, the superior of the fire-fighting force of the metropolis. One of these departments may be found in the city of Pittsburg, Pa. While, in point of numbers, the department has but one-fourth the apparatus which comprises that in New York, the department is thoroughly up-to-date in every way.

In Pittsburg the fire department is known as a "bureau," and is one of the seven that go to make up the Department of Public Safety. Thus the chief engineer of this bureau is responsible to the director of the department and not directly to the Mayor, as is the Fire Commissioner in New York. The present chief of fire is Miles S. Humphreys, who has held the position for several years. It is a strange fact that he never served as a fireman in the ordinary sense of the term, but his administration of his bureau has been of the ablest and the service that his men have rendered the public has been in a great measure due to the personal supervision of their head.

The fire-fighting forces of the city comprise about thirty engine companies, including those having chemical apparatus, besides nearly a dozen companies of hook and ladders. The latest addition to the apparatus is a combination water-tower, hose wagon and chemical engine, which is claimed to be the only one of its kind in the country. It matches the big automobile engine now in use, and is one of the most complete pieces of fire apparatus made. The tower can be raised to a height of twenty-three feet, and the chemical tank, which has a capacity of 100 gallons, is situated between the rear wheels under the bed of the wagon. The wheels are ball-bearing and rubber tired, and there are patent friction brakes which can be operated from front and rear. The wagon was built for use in narrow streets and alleys, and is stationed in the downtown district. The accompanying illustrations show some of the apparatus at work at the fire in the Pennsylvania Door and Sash Company's factory in Pittsburg, in which five men were injured and the loss amounted to $85,000. One of the illustrations shows a water-tower in operation at this fire.

THE PITTSBURG FIRE DEPARTMENT FIGHTING A BIG BLAZE.

While the city of Pittsburg has the best of apparatus, the supply of water is not proving adequate for its needs. Fire Marshal McGill is urging the authorities to install a larger water supply and many more fire plugs. He claims that many of the water mains have been underground for many years, and are not fit for use. The number of hydrants is not proving sufficient, and he points out that at a recent fire it was necessary to feed the water-tower through 2,000 feet of hose, consequently the stream from the tower was practically useless. His recommendations will be heeded, as the number of large fires that have taken place lately have shown that it is useless to have good apparatus if there is not a large enough supply of water to render them effective.—Municipal Journal and Engineer.



PITTSBURG'S NEW WATER TOWER—SMALLEST IN THE COUNTRY.

VOLCANIC ACTION AS A CAUSE OF OUTBREAKS OF EPIDEMIC DISEASE.

UNDER this heading Dr. Noel Bardswell, of the Deeside Sanatorium, at Banchory, Aberdeenshire, wrote an essay which gained the Parkin prize of the Royal College of Physicians of Edinburgh in 1900, and is published in the October number of the Edinburgh Medical Journal. In 1851 Dr. John Parkin, from whom this prize derives its name, brought out a large work on "The Remote Cause of Epidemic Diseases," in which he took the view that volcanic action was to be re-

garded as a factor in the causation of cholera and other epidemic diseases. Speaking generally the countries most liable to earthquakes are Portugal, Italy, Beloochistan, Afghanistan, the Bengal Presidency of India, Japan, Mexico, and the Pacific Coast of South America. Dr. Bardswell is of opinion that the presence of volcanic activity in a country as a whole has no obvious effect on the death-rate or incidence of epidemic diseases, but there is an evident difference in this respect between the volcanic and the non-volcanic portions of such countries. He applies this argument to selected portions of the United States of America and to selected portions of Italy, but, as he himself admits, the results obtained in this way must be received with caution. It seems to him, however, to be not unlikely that volcanic action may have an effect on the mortality in towns possessing modern water-supply and drainage systems. Yokohama in Japan is situated in a district almost constantly under the influence of seismic disturbance and formerly had a very high death-rate from epidemic diseases, especially cholera and typhoid fever, but since the reservoirs and other water receptacles have been incased in puddle-clay and special precautions have been taken in the laying of the water-mains the health of the town has greatly improved. The methods adopted to guard against injury to the water service by earthquake shocks have been described by Mr. Turner in the Transactions of the Institute of Civil Engineers, Vol. C. In 1887 a fairly severe shock of earthquake traversed the Riviera and did a great deal of damage. In addition to the destruction of houses, great cracks were made in cesspools and drainage-pipes were rendered leaky. In the three towns of Nice, Cannes, and Mentone the combined deaths from enteric fever were as follows: 41 in 1886, 66 in 1887, 115 in 1888 (the year after the earthquake), and 84 in 1889. The effect of earth tremors upon drainage and water-supply systems is, therefore, of much practical importance in certain localities.

RECENT EXPERIMENTS IN ATTACKING ARMOR WITH HIGH EXPLOSIVE SHELL.*

By E. B. Babbitt, Captain of Ordnance, U. S. A.

The struggle between the armor and the projectile is drawing to a close. The limit of flotation has practically settled the thickness of armor to be carried, and the manufacturers now bend their energies, with remarkable success it is true, to *improving* the armor.

With all this, however, the projectile is in the lead, and has now brought to its assistance the valuable aid of high explosives.

The Ordnance Department of the army has been experimenting for many years to secure a high explosive for a shell filler, and with varying success. In the reports of the Ordnance Board conducting these tests in 1883, 1884, and 1885, they usually concluded with "burst at the muzzle" or "destroyed the gun." Naturally, then, the problem, as it presented itself to them, was to secure an explosive that could safely be fired from a high-powered gun. As we approach it now, that is really but a corrolary to the condition that it will not explode on impact on armor, as the shock in the latter case is so much greater.

When the Board of Ordnance and Fortification was organized the tests with high explosives took a wider range, due partly to the larger fund at its disposal and partly to the increased activity of the manufacturers for a time.

The subcommittee of this Board considered at length this subject and reported:

It appears that the following points are to be investigated:

First—Which is the best explosive for use in shells.

Second—Is an explosion of the first order, or detonation, assured with the different methods of loading proposed by the inventors to prevent premature explosion.

Third—Will the explosive stand the friction due to rifled motion when loaded as proposed.

Fourth—Will the explosive stand the shock of firing when loaded as proposed by the different inventors.

Fifth—Will the igniting mechanism stand the shock of firing and the rifled motion without premature action.

Sixth—Will the igniting mechanism act as desired.

Seventh—Will the shell, without the igniting mechanism, explode on impact with water, with earth, with stone, with wood, or light iron, and with iron armor.

Considering these it appears:

That the first is the summation of those that follow.

The second, in its investigation, led to extensive subterra experiments which, while instructive, really led the investigators from the true scope, namely, to get an explosive that could be used in a shell.

The third condition was quite a bugaboo, and comes to us even to-day. I have my doubts as to its importance.

In a moment of mental aberration I devised a fuse depending for its action upon a plunger within remaining at rest while the envelope took up the rotation of the projectile. I had no doubt about this feature, but, wishing to investigate another, made such a plunger, supported, by the way, by an axial shaft, thus reducing the frictional moment, and fired it from a field gun into a sand butt. When recovered and opened—behold! the plunger had not moved in its housing. Thus ended a threatened revolution in the fuses of the world.

As my brother officer, Capt. Crozier, would say, "Ideas are cheap; worth about twenty-five cents a bushel;" when one is developed into something tangible, it is priceless.

Of the remaining conditions, those regarding the fuse or firing mechanism are important, since in the later development a successful explosive waited on a satisfactory fuse.

At the time of this report, 1891, there were before the Board explosive gelatine, guncotton, emmensite, Schwalin mixture, and americanite. Of these guncotton alone is now considered as a shell filler, and then only wet and with a matrix.

Between 1892 and 1896 there were tested in addition:

Terrorite (n. g. and nitroethyl and nitromethyl).

Rackarock—a Spengle safety mixture.

Ammonite—90 per cent ammonium nitrate and 10 per cent mono-nitro-naphthalene.

Jovite—87 NH_4NO_3 and nitro-phenols and nitro-naphthalene. None met with success. Between 1896 and 1898 the Ordnance Department experimented largely with guncotton, in various forms and degrees of moisture, and met with considerable success, thanks to a detonating fuse devised by Lieut., now Capt. W. S. Peirce, Ordnance Department.

In 1898 thorite began its brilliant but short career.

The sensitiveness of most of the high explosives brought forth during this period many novel ideas for firing them with safety, the most notable being the famous pneumatic dynamite guns, three of which were mounted on the "Vesuvius," and were used at Santiago with so little effect. As late as August 23, 1899, a charge of 129½ pounds explosive gelatine was fired from a 12-inch service rifle using an Isham diaphragm shell. The explosion of this mass against a 12-inch plate failed, on impact, to rupture the plate but moved it bodily. More damage was done to a similar plate with a service armor piercing shot, uncharged.

With the reorganization of the Ordnance Board in 1899 was introduced the present system of investigation, which, in its workings, has brought about conclusive results, and has, it is thought, given a most satisfactory explosive and fuse; in other words, a most powerful weapon for attack, superior to any possessed abroad of which we have any knowledge.

I can do no better than quote the following reply of the Ordnance Board to a letter from the Chief of Ordnance asking about the status of the question of high explosives for shell:

"From the nature of the subject it is evident, and experience has amply demonstrated the fact, that the selection of a high explosive shell which shall be thoroughly efficient and yet safe beyond any reasonable doubt to store, handle, and fire under all conditions of service, presents a most difficult problem which offers chances of failure at every step and can be considered solved only when these requirements are satisfactorily established by exhaustive tests. The destructiveness of the explosive makes it a constant menace to the men and material using it, and a perfected projectile involves not only the explosive but the fuse and the method of constructing the shell also."

A satisfactory high explosive for shell should fulfill the following requirements:

SAFETY AND INSENSITIVENESS.

First—Should be reasonably safe in manufacture and free from very injurious effects upon the operatives.

Second—To warrant further test, must show a relatively safe degree of insensitiveness in the impact testing apparatus used by the department.

Third—Must withstand the maximum shock of discharge under repeated firings in the shells for which it is intended.

Fourth—Must withstand the shock of impact when fired in unfused shells as follows:

(a) Field shell. Maximum velocity against 3 inches of oak timber backed by sand.

(b) Siege shell. Against seasoned concrete thicker than the shell will penetrate, with remaining velocity for full charge at 500 yards range.

(c) Armor-piercing shell. Against a 7-inch tempered steel test plate in a 12-inch A. P. shell with a velocity just sufficient to penetrate.

DETONATION AND STRENGTH.

Fifth—Must be uniformly and completely detonated with the service detonating fuse.

Sixth—Should possess the greatest strength compatible with other necessary requirements.

STABILITY.

Seventh—Must not decompose when hermetically sealed and subjected to a temperature of 120 deg. F. for one week.

Eighth—Should be preferably non-hygroscopic, and must not have its facility for detonation affected by moisture that can be absorbed under ordinary atmospheric exposure necessary in handling.

Ninth—Must not attack ordinary metals used in projectiles and fuses to an extent that cannot be prevented by simple means.

Tenth—Must not deteriorate or undergo chemical change in storage.

GENERAL CONDITIONS.

Loading.—This must not be attended with unusual danger, and should not require exceptional skill or tedious methods. It is very desirable that the explosive be capable of compact loading either by melting or compressing into solid blocks.

Supply.—Should be possible to procure the explosive quickly and in quantity in this country at a reasonable cost.

To carry out investigations covering all these conditions involved constructing a comprehensive scheme of test and the expenditure of much money. The object being to get the explosive through armor, the final test would naturally be a practical trial under service conditions. These costing from $3,000 to $5,000 per round could be very few and means had to be devised for an early elimination of those doomed to failure.

We, therefore, first determined:

First—The relative force (by calculation) for actual density of loading in shell.

Second—Specific gravity.

Third—Density of loading.

Fourth—Charge contained in 100 cubic inches.

Fifth—Approximate cost of charge.

Sixth—Ease of supply.

Seventh—Method of loading.

Eighth—Safety in manufacturing.

Ninth—Stability in heat test.

Tenth—Non-hygroscopic.

Twelfth—Non-active on metals.

If the above were satisfactory the explosive was tested in an impact testing machine devised by Capt. Dunn, a member of the Board. In this is provided a shallow cup in an anvil capable of holding a few grains (by weight) of the explosive in such a manner as to prevent lateral expansion.

By noting the height of fall of a known weight

Shell charge.	No. of rounds.	Plate (thickness), inches.	Action of shell.
Sand..........	2	1.5 T.	Penetrated target. Recovered whole.
Black powder..........	1	1.0 T.	Penetrated target and burst 4 feet in rear.
	1	1.5 T.	Penetrated target and burst close behind.
	1	2.0 T.	Penetrated target and burst 3 feet in rear.
No. 400 explosive..........	2	1.0 T.	Penetrated target and burst 30 inches in rear.
	1	1.5 T.	Penetrated target and burst close in rear.
Picric acid..........	2	1.0 T.	Penetrated target. Both had plug blown out between target and butt. Low order of explosion.
	2	1.5 T.	Both penetrated plate. One deflected to sea and lost; one exploded violently in backing.
	1	2.0 T.	Exploded in plate. Point passed through target and base blown to rear over gun shelter.
Gun cotton..........	1	1.5 T.	Penetrated target and recovered whole. Charge slightly set forward at rear.
	1	2.0 T.	Penetrated target and exploded in butt.
10% maximite..........	1	2.0 T.	Penetrated target and entered butt apparently whole. Not recovered
	2	3.0 M.	One penetrated target and recovered whole. Charge not disturbed. One stuck in plate with base imbedded 1.5 inches. Charge slightly set forward at rear.
25% maximite..........	1	1.5 T.	Penetrated target and recovered whole. Charge not disturbed.
	1	2.0 T.	Same, except charge slightly set forward at rear.
	2	3.0 M.	One penetrated target and recovered whole. Charge slightly disturbed at rear. One stuck in plate, head projecting about one-half through, not exploded.
Explosive "D"..........	2	2.0 T.	Penetrated target and recovered whole. Charge slightly disturbed at rear.
	2	3.0 M.	One same as preceding. One stuck in plate and broken in two across middle section; explosive not ignited.

(T., tempered; M., mild steel plate.)

* Read at the ninth general meeting of the Society of Naval Architects and Marine Engineers, held in New York, November 14 and 15, 1901.

the relative insensitiveness is determined. It is of interest to know that, in every case, subsequent armor tests have borne out the conclusions reached with this little machine. Having once determined a limiting drop, below which an explosive would fail in a gun, it is easy to reject, without firing, all those below that limit, and indeed select only those approaching a higher drop limit that would indicate insensitiveness to impact.

A projectile acquires its velocity in passing over the entire length of the bore of a gun, but, if stopped by an armor plate, is arrested in a very small fraction of the first distance. It is, therefore, evident that the shock of impact is the severer test, and it is here that the tests become most interesting.

We have no means of determining the law of retardation in a plate, so for comparison are forced to assume that it is constant over the path.

Under this assumption, considering the length of column of the explosive in each service shell, and the armor against which it is tested, it can be shown that the shock to the explosive in a 6-pounder shell against a 3-inch nickel steel plate is greater than in any of the service tests. For this reason, and on account of the relative inexpensiveness, the 6-pounder rapid fire gun was selected for the preliminary tests against armor. Standard plates 1-inch, 1½-inch, 2-inch, and 3-inch, are used and firings made at each in order, till either the explosive bursts on impact, or successfully resists the highest plate.

The results of the first series of tests following this method are as follows:

Summary of Tests of 6-Pounder Steel Shell Charged with High Explosives and Fired (Unfused) Against Steel Plates of Varying Thickness.

Plates.—Braced against 6-inch oak backing (110 feet from gun) with intervening clear space of 20 feet to sand butt in rear—so placed in order to observe action of shell after penetrating target, and to collect fired shell or their fragments from the butt. The following plates were used:

Carnegie tempered (nickel steel) plates, 36 by 36 inches, 1, 1.5 and 2 inches thick.

Fragments of mild steel plate, 3 inches thick.

Carnegie tempered (nickel steel) plate, 38 by 40 inches, 3 inches thick.

Projectiles.—Six-pounder A. P. shell, steel, for which the acceptance test requires penetration of a 3-inch mild steel plate, without fracture, base fuse dismantled and brass fuse stock cut off to be flush with the rear end of shell cavity when screwed home; hollow in stock filled with plaster of paris. The projectiles were filled, flush with the inner end of fuse hole, through base, with the following explosives:

First—Black musket powder, filled loosely into shell cavity—average charge 4 ounces.

Second—Rendrock Company's No. 400 explosive, heated to pasty condition, and tamped with wood stick in shell cavity—average charge 9.08 ounces.

Third—Picric acid, melted and poured into shell cavity—average charge 6.41 ounces.

Fourth—Guncotton pellets containing 15 per cent moisture, loaded with matrix formed of 60 parts paraffine, 25 parts resin, and 15 parts beeswax—average charge 2.025 ounces.

Fifth—Ten per cent maximite, melted and poured into shell cavity—average charge 5.85 ounces.

Sixth—Twenty-five per cent maximite, melted and poured into shell cavity—average charge 6.075 ounces.

Seventh—Explosive *D*, in powder, tamped as well as possible with wood stick through fuse hole—average charge 4.375 ounces.

It is seen that the black powder, No. 400 explosive, and picric acid, all failed to penetrate the 1-inch tempered steel plate without explosion; some superiority for picric acid is only shown in that the explosion was less violent than with the other two. The 1.5-inch plate produced a violent explosion of picric acid as well as of black powder and No. 400 explosive. Guncotton passed the 1.5-inch plate test but failed with the 2-inch plate.

The two grades of maximite and explosive "D" passed the 2-inch plate test and also the test with 3-inch mild steel to which they were subjected. A 3-inch tempered steel plate was then mounted to give an extreme test for these explosives. The powder charge was increased to give a striking velocity of 1,920 f/s, with which four rounds were fired, and also two rounds fired with a charge giving a striking velocity of 1,970 f/s., viz.:

These tests led to the selection of two explosives, namely, maximite and explosive "D," as worthy of final test.

Owing to the impossibility of controlling the explosives in an ordinary explosive chamber, fragmentation tests are made by burying the larger shell, fully charged and fused, about ten feet in sand and firing the fuse electrically. Fragments are then dug out, weighed and counted. Careful search is made for any unexploded material.

The following extract from these fragmentation tests gives an idea of the results obtained:

1.—Twelve-inch A. P. shell, maximite, buried 10 feet in sand. Frankford Arsenal A. P. detonating fuse.

	Lbs.	Oz.
Weight of empty shell and fuse....	960	4
Weight of explosive charge..........	50	12
	1,011	0
Weight of metal recovered..........	827	7
Number of fragments counted.......	3,690	
Number of fragments—small pieces, estimated	2,718	

2.—Twelve-inch A. P. shell charged with explosive "D," buried 12 feet in sand. Frankford Arsenal detonating A. P. fuse.

	Lbs.	Oz.
Weight of empty shell and fuse......	951	4
Weight of explosive charge..........	57	12
	1,009	0
Weight of metal recovered..........	815	
Number of fragments...............	850	

The first result quoted above is much above the average and has not been duplicated. Indeed there is a limit to the size of useful fragments. A large number of fair-sized fragments driven with high velocity throughout the interior of a vessel would cause more damage than a much larger number of small fragments.

Such a statement is always subject to modifications; if, for example, a shell should burst in a crowded part of the vessel, as was the case in the turret of the Japanese flagship at the battle of the Yalu, the more violent explosion would be more disastrous.

Both explosives having met all requirements up to this point there remained the final tests against armor.

Twelve-inch armor-piercing shot having sufficient velocity for penetration are required to pass through a 12-inch face-hardened plate before the lot represented by the projectile is accepted. This was, therefore, adopted as the final test for the explosives, namely, that they must withstand the shock of impact of such a projectile on such a plate. It was led up to by firing first a 5-inch shell through a 3-inch tempered plate. Next, a 12-inch A. P. shell through a 7-inch tempered plate, and finally a 12-inch A. P. shot (capped) through a 12-inch harveyized plate.

All the above were unfused, and, in every case, the projectiles were recovered and, later, fragmented to increase our data on this subject.

It should be stated that all armor plates are supported by heavy backings of oak strongly braced, and in rear of this is a large mound of sand in which the projectile finally comes to rest. At last the final test was reached.

Imagine the tension as, from a safe distance, we stood with eyes to our glasses anxiously watching the distant field. The target, a 5¾-inch tempered steel plate, well backed with oak, defiantly faces the long, slender 12-inch rifle. The red flag waves from the firing bomb proof. It is answered. The flag falls, a bank of smoke from the gun, a flash of light at the plate, a dense, black, foreboding mass of smoke interspersed with flying timbers and bits of plate, two mighty roars in quick succession, a sigh of relief and satisfaction from the observers, and, for the first time, a 12-inch armor-piercing shell, loaded and fused, has passed through heavy armor. While, later, heavier plates were used and the results therefore more satisfactory, the first success ever stands out most vividly in the minds of the experimenters.

The official record of this test reads as follows:

No. 7.—Twelve-inch A. P. shell charged with explosive "D," 58½ pounds.

Weight of charged shell, complete, 1,021 pounds.

Fired March 27, 1901, with Frankford Arsenal detonating A. P. fuse complete against 5¾-inch tempered steel plate. Striking velocity 1,475 f/s. Shell penetrated plate and detonated immediately in rear. Plate broken and carried forward with numerous fragments of shell.

Tests against 7-inch steel plates and 12-inch face-hardened plates followed with great success. Finally, encouraged by the successful results, a 12-inch A. P. shell (the test of which is a 7-inch steel plate) was fired against a 12-inch face-hardened plate. The record reads:

No. 11.—Twelve-inch A. P. shell charged with explosive "D," 58.6 pounds.

Weight of charged shell, complete, 1,010 pounds.

Fired May 17, 1901, with Frankford Arsenal detonating A. P. fuse complete against a piece of 12-inch face-hardened steel plate. Pressure in gun 29,900 pounds per square inch. Velocity about 1,875 f/s.

Shell detonated in plate and completely demolished plate and backing—all being carried forward and swept away. Fragments of plate were thrown to a distance of 200 to 300 feet, and gave evidence that the plate was penetrated by the shell.

In summing up the final tests we find:

	Explosive "D."	Maximite.
Shell fragmented by detonating fuse..	8	11
Shell fired from gun unfused.........	13	13
Shell fired from gun fused............	13	10
	34	34
Results entirely satisfactory with respect to explosive................	34	33
Premature action of explosive cases, afterward remedied	—	1
Fuses acted feebly—remedied........	3	1
Fuses failed	1	—

Before closing, it is necessary to mention a most important factor in this success, namely, the fuse. But of this little can be said. It is the secret of all our triumphs, and as such is being carefully guarded. It, like the explosive, passed through various stages. It was tested separately for its power to detonate the shell charges; its power to resist shock of discharge and impact; and, finally, under service conditions. It had its failures in the early stages, but, thanks to the skill and energy of Capt. Beverly W. Dunn, Ordnance Department, U. S. A., won out in the end.

One of the most serious questions connected with an armor-piercing fuse is its delay action. Introducing, as it does, the time element, it is evident that an interval suited to light armor would not be satisfactory for heavy when the time of penetration is greater. As by far the greater part of a ship's protection is relatively light armor, a delay sufficient to cause detonation a few feet after penetration seems best. This gives us a burst when a shot is still in the 12-inch plate, but has penetrated.

I think I am safe in saying that the results just enumerated are unique, and so far surpass those previously obtained as not to admit of comparison with them.

VELOCITY 1,920 f/s.			
Shell charge.	**No. of rounds.**	**Plate (thickness), inches.**	**Action of shell.**
10% maximite........	1	3 T.	Struck squarely, and point passed 4½ inches beyond front face of plate. Shell broken and fragments rebounded, leaving clean hole. Explosive ignited, as shown by cloud of smoke.
25% maximite	1	3 T.	Point penetrated about 4.25 inches. Shell rebounded 110 feet, badly set up. No explosion.
Explosive "D"...........	2	3 T.	One with same penetration as preceding, and one striking somewhat obliquely, penetrated about 3 inches; both broken. Explosive formed cloud of powder; not ignited.
VELOCITY 1,970 f/s.			
25% maximite..	1	3 T.	Badly upset and broken on plate. Cup-shaped hole about 1.5 inches deep. Explosive ignited, as shown by cloud of smoke.
Explosive "D"...........	1	3 T.	Same as preceding, except hole 1.7 inches deep. Explosive formed cloud of powder; not ignited.

GEOGRAPHICAL EXPOSITION AT ANTWERP.

VICE-CONSUL-GENERAL HAINE sends from Antwerp, October 26, 1901, translation of a circular letter from the Royal Geographical Society, announcing the organization of an exposition to be called "Exposition Cartographique, Ethnographique et Maritime," to be held at Antwerp in 1902 in commemoration of the twenty-fifth anniversary of the society's foundation. The circular reads:

We have the honor to announce that in order to worthily celebrate the twenty-fifth anniversary of the foundation of the Royal Geographical Society of Antwerp, it has been decided to organize an exposition to be called "Exposition Cartographique, Ethnographique et Maritime."

His Majesty the King has given the project his approbation, and the exposition will be held in the building of the old museum at Antwerp, rue Venus, to be opened in the month of May next. The object of the committee is to popularize geographical sciences, to make those countries recently opened to commercial activity better known, and to contribute to the development of the mercantile marine and of maritime enterprises. There will be a section devoted to ancient and modern maps and globes, surveying instruments, etc., which will comprise also meteorological and ocean-sounding apparatus. The committee proposes to assemble important ethnographical collections, in view of the interest taken in them by the public in regard to transoceanic enterprises. The participation of the Kongo Free State will largely contribute to the success of this section. Besides the colonial section, there will be a department devoted to everything relating to the progress of navigation. Models of ships and of great maritime works, improvements in the art of navigation, and trophies of voyages of exploration will be exhibited. It is desired to give to the exhibition an international character, as it is wished to signalize the great examples of the colonial and maritime powers and the progress realized by them.

ARTIFICIAL FERTILIZER IN SOUTH AUSTRALIA.

CONSUL-GENERAL HUGHES writes from Coburg, October 23, 1901, that according to German reports, the importation of artificial manures into South Australia has grown enormously since 1897. In 1899, besides the 4,000 tons produced in the colony, 12,000 tons were imported; in 1900, 3,400 tons of the home product were used and 21,206 tons were imported, and for the present year it is estimated that 31,400 tons will be wanted, of which quantity 26,400 tons will have to be imported. The value of the manure imported so far this year amounts to $540,000. The 31,400 tons for this year can be classified as follows, viz.: 25,000 tons of mineral superphosphate, 2,700 tons of bone and guano, 1,600 tons of Thomas meal, and 1,600 tons of bone dust, etc. Of the gross amount, Great Britain supplies about 21,500 tons, Germany 2,500 tons, New South Wales 1,300 tons, and Victoria about 500 tons. The consul-general thinks the United States should have a share of this trade.

LIQUID HYDROGEN.*

By Prof. DEWAR, M.A., LL.D., F.R.S., M.R.I.

MY colleague, Lord Rayleigh, in his commemoration lecture dealt so admirably and exhaustively with some of the discoveries of our great predecessors in this institution that it will be unnecessary to pursue further the lines of historical treatment in this lecture. Instead of discoursing generally on the chemical side of the work of Davy and Faraday and their successors, it has seemed to me more appropriate to attempt some experimental demonstrations of the latest modern developments in a field of inquiry opened out to science by the labors of the two illustrious chemists just mentioned. With this object in view, my discourse this evening will be confined to the subject of liquid hydrogen. Davy said: "Nothing tends so much to the advancement of knowledge as the application of a new instrument. The native intellectual powers of man in different times are not so much the causes of the different success of their labors as the peculiar nature of the means and artificial resources in their possession." The new instrument of research, which for the first time we have to experiment with before an audience, is the liquid form of the old inflammable air of Cavendish. Lavoisier toward the end of the last century had the scientific acumen to declare that, in his opinion, "if the earth were suddenly transported into a very cold region, the air, or at least some of the aeriform fluids which now compose the mass of our atmosphere, would doubtless lose their elasticity for want of a sufficient temperature to retain them in that state. They would return to the liquid state of existence and new liquids would be formed, of whose properties we cannot at present form the most distinct idea." Black, about the same time, in discussing the properties of hydrogen, makes the following suggestive observations: "We may now further remark, with regard to inflammable air, that it is at present considered as one of the simple or elementary bodies in nature. I mean, however, the basis of it, called the hydrogen by the French chemists; for the inflammable air itself, namely, hydrogen gas, is considered as a compound of that basis and the matter of heat. What appearance and properties that basis would have, were it deprived of its latent heat and elastic form, and quite separated from all other matter, we cannot tell." The accuracy of the prophecy of Lavoisier has been experimentally verified, but until recently we had no distinctive answer to the riddle of Black. The object of this lecture will be an attempt to advance the solution of the problem suggested by Black a century ago. It is interesting to note how confident Faraday was that hydrogen would ultimately be obtained in the liquid and solid form. In the course of one of his lectures delivered in the year 1852 he said: "There is reason to believe we should derive much information as to the intimate nature of these non-metallic elements if we could succeed in obtaining hydrogen and nitrogen in the liquid or solid form. Many gases have been liquefied; one, carbonic acid gas, has been solidified; but hydrogen and nitrogen have resisted all our efforts of this kind. Hydrogen, in many of its relations, acts as though it were a metal; could it be obtained in a liquid or solid condition the doubt might be settled. This great problem, however, has yet to be solved; nor should we look with hopelessness on this solution, when we reflect with wonder—and, as I do, almost with fear and trembling—on the powers of investigating the hidden qualities of these elements, of questioning them,

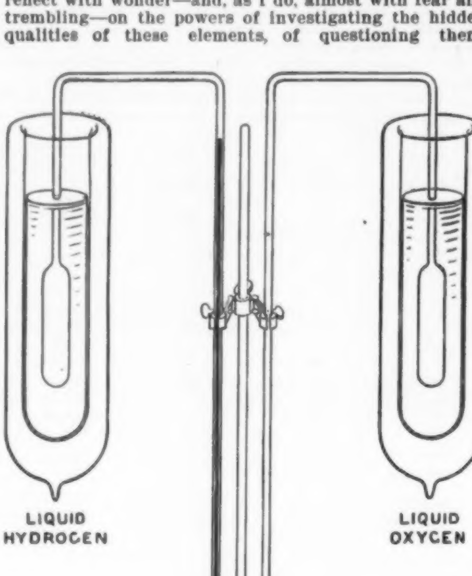


FIG. 4.—LIQUID HYDROGEN EXPERIMENTS.

making them disclose their secrets and tell their tales, given by the Almighty to man." It must be confessed, however, that later physicists and chemists were almost forced to conclude that the problem was a hopeless one. The full history of the liquefaction of hydrogen has been dealt with in a Friday evening discourse* delivered in January of this year, so that all questions dealing with the work of other investigators may for the present be omitted in order to save time for the experimental illustrations.

This large spherical double-walled and silvered vacuum vessel contains one liter of liquid hydrogen. You observe it is lifted out of a large cylindrical vessel full of liquid air. In order to diminish the rate of evaporation it is necessary to surround the vessel in which the hydrogen is collected with liquid air. Under such conditions the rapidity of evaporation is about the same as that of liquid air when kept in a similar vessel in the ordinary way. In order to prove that hydrogen is present in the liquid form the simplest experiment is to remove the cotton-wool plug, which takes the place of a cork, and insert a metallic wire, to the end of which is attached a ball of asbestos for the purpose of absorbing the liquid. On bringing it quickly into the air and applying a light it burns with the characteristic appearance of the hydrogen flame (*C*, Fig. 3). The liquid can readily be poured from one variety of vacuum vessel into another, so that by means of this unsilvered cylindrical form the appearance of the liquid and other experiments may be projected on a screen (*A*, Fig. 3). The liquid hydrogen appears in gentle ebullition and is perfectly clear, only there is a white solid deposit in the bottom of the tube, which is really solid air. This may be shown by removing for an instant the cotton-wool stopper, when you see a snow of solid air falling in the liquid. It is easy to arrange a method of carrying liquid hydrogen in a small vacuum vessel in such a way as to prevent the access of air. This is shown in Fig. 1, where the vacuum vessel, after it has been filled by dipping it into the main supply by means of a supporting wire, is surrounded with a glass envelope, which becomes filled with an atmosphere of hydrogen gas constantly maintained, thereby preventing the access of air. That the density of the liquid is very small and is altogether unlike liquid air is shown by dropping small pieces of cork, which float readily in the latter liquid but sink instantly in the hydrogen (*B*, Fig. 3). The real density of the liquid is only one-fourteenth that of water, so that it is by far the lightest known liquid. This small density explains the rapidity with which the liquid is cleared on the entrance of the air snow. The relative smallness of the gas bubbles produced in the actively boiling liquid, which causes an appearance of opalescence, is really due to the small surface tension of the liquid hydrogen. The coefficient of expansion of liquid hydrogen is some five times greater than that of liquid oxygen, and is comparable with that of carbonic acid, about 5 deg. from its critical point. The latent heat of evaporation is about 190 units, and the specific heat of the liquid is very high, and, so far as my experiments go, leads me to the value 6. This is in very marked contrast to the specific heat of liquid oxygen, which is about 0.5. The extraordinary lowness of its boiling point is at once apparent by cooling a piece of metal in the liquid and then removing it into the air, when it will be seen to condense for a moment solid air on its surface which soon melts and falls as a liquid air. This may be collected in a small cup, and the production of oxygen demonstrated by the ignition of a red-hot splinter of wood after the chief portion of the nitrogen has evaporated. If a long piece of quill tubing sealed at one end, but open at the other, is placed in the liquid, then the part that is cooled rapidly fills with liquid air. On stopping any further entrance of air by closing the end of the tube the liquid air quickly becomes solid,

* Centenary commemoration lecture, Royal Institution of Great Britain, Wednesday, June 7, 1899, His Grace the Duke of Northumberland, K.G., president, in the chair, by Prof. Dewar, M.A., LL.D., F.R.S., M.R.I., Fullerian Professor of Chemistry R. I.—From the Annual Report of the Smithsonian Institution for 1900.

* Reprinted in Smithsonian Report, 1899, pages 131-142.

FIG. 1.

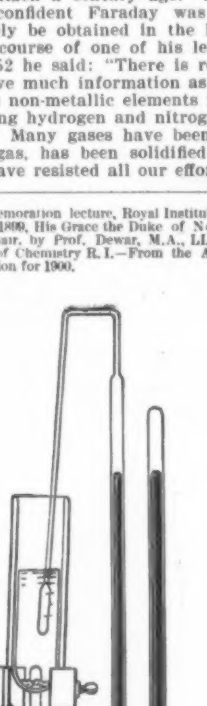


FIG. 2.

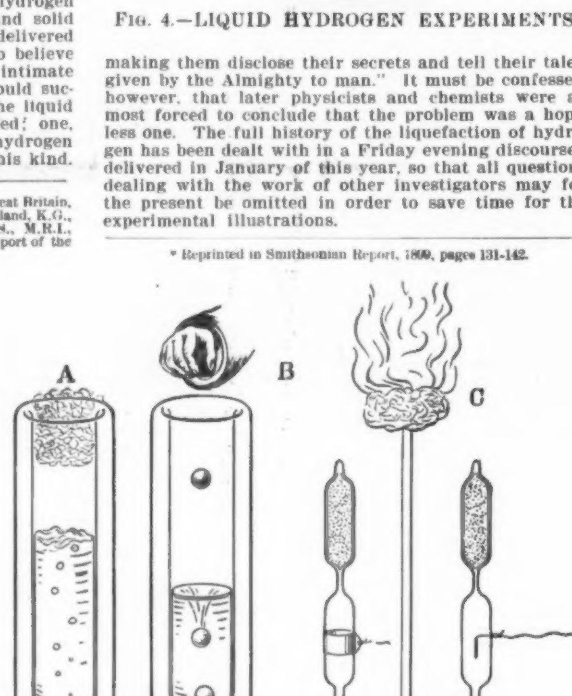


FIG. 3.

LIQUID HYDROGEN EXPERIMENTS.

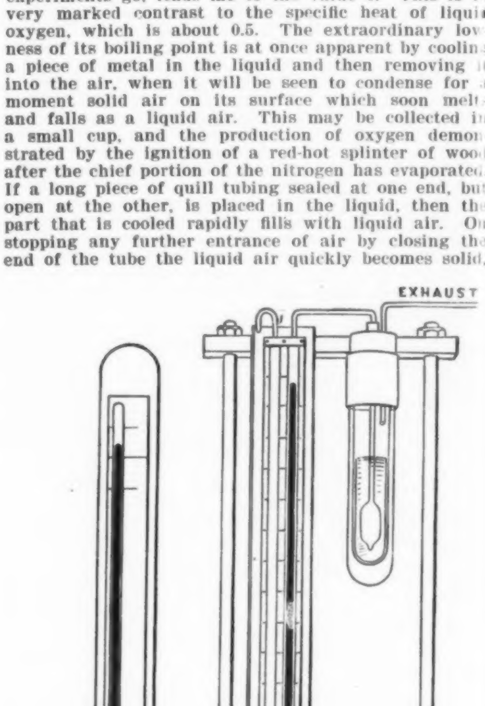


FIG. 5.

showing in the interior a hollow spindle from contraction, in passing from the liquid into the solid form (*E*, Fig. 3). On bringing the tube containing the solid from the liquid hydrogen bath into the air we observe liquid air running from the surface while the solid air inside is seen to melt (*D*, Fig. 3). Here is a tube into which liquid oxygen has been poured. On placing it in liquid hydrogen it freezes to a clear blue ice. Liquid nitrogen under similar circumstances forms a colorless ice. If instead of an open tube in free air we employ a closed vessel of about a liter capacity to which the quill tube is attached, then, on repeating the experiment, the same results follow, only the volume of the liquid air formed agrees with the total quantity present in the vessel. This suggests that any air left in the closed vessel must have a very small pressure. This is confirmed by attaching a mercurial gage to any vessel containing air, when it will be seen the vacuum produced by hydrogen cooling is equal to that of a Torricellian vacuum (Fig. 2). To reach such a high exhaustion the solid oxygen and nitrogen at the boiling point of hydrogen must be practically non-volatile or have an exceedingly small vapor pressure. If the ordinary air contains free hydrogen, helium, etc., which are non-condensable in this way of working, then the vacuum would not be so high as with pure oxygen or nitrogen. This method may be used to separate the incondensable gases from the air. Such air vacua when examined spectroscopically show the lines of hydrogen, helium, and neon. We may now employ this process to produce high vacua, and test their exhaustion by the character of the electric discharge. Vacuum tubes which have been prepared in this way show extraordinary resistance to the passage of the electric discharge; they also show the marked phosphorescence of the glass characteristic of Crookes tubes (*F* and *G*, Fig. 3). It is, however, the rapidity with which such high exhaustions can be attained that is so interesting. You will observe that this large Geissler tube, previously exhausted to some three inches' pressure, will, when the end part is immersed in liquid hydrogen, pass through all the well-known changes in the phases of striation—the glow on the poles, the phosphorescence of the glass—in the space of a fraction of a minute. From this it follows that theoretically we need not exhaust the air out of our double-walled vessel when liquid hydrogen has to be stored or collected. This makes a striking contrast to the behavior of liquid air under similar circumstances. The rapid exhaustion caused by the solidification of the air on the surface of a double-walled exhausted test tube, when liquid hydrogen is placed in it, may be shown in another way. Leave a little mercury in the vessel containing air, just as if it had been left from making a mercurial vacuum. Now, we know mercury in such a vacuum can easily be made to distill at the ordinary temperature when we cool a part of the vessel with liquid air, so that we should expect the mercury in the unexhausted test tube to distill on to the surface cooled with the liquid hydrogen. This actually takes place. A rough comparison of the relative temperatures of boiling hydrogen and oxygen may be made by placing two nearly identical hydrogen-gas thermometers operating at constant pressure side by side and cooling each with one of the liquids (Fig. 4). It will be seen that the contraction in the thermometer cooled with liquid hydrogen elevates the liquid some six times higher than that of the corresponding liquid column of the thermometer placed in the liquid oxygen. A constant-volume hydrogen thermometer constructed as shown in Fig. 5, gave the boiling point of 21 deg. absolute or —252 deg. C. and a similar helium thermometer gave the same result. The critical temperature is about 32 deg. absolute or —241 deg. C., and the critical pressure about 15 atmospheres. If a closed vessel is full of hydrogen gas at atmospheric pressure, then, unlike the air vessels, it shows no condensation when a part of it is cooled in liquid hydrogen. To produce liquefaction we must increase the pressure of the gas or reduce the boiling point of the liquid hydrogen by exhaustion. Pure hydrogen liquefied in a closed vessel is perfectly clear, showing no trace of color or any appearance of absorption bands in the position of the spectrum lines. Electric sparks passing in the liquid when examined with the spectroscope show the ordinary line spectrum without any reversals. The vapor of boiling hydrogen is about fifteen times denser than that of the ordinary gas, thus bringing it up to the density of air. The liquid hydrogen, at its boiling point, is about sixty times denser than the vapor coming off. In the case of oxygen the density of the liquid is 255 times that of the vapor at its boiling point.

If a piece of cotton wool in the form of a little ball is attached to a thread, placed in liquid hydrogen, and then brought into the magnetic field, it is found to be strongly magnetic. This is simply due to the condensation of solid and liquid air in the pores of the wool. This substance we know is magnetic on account of the oxygen it contains. Pure liquid hydrogen is not magnetic, but when the solid air snow is in suspension in the fluid, then the magnetic character of the latter becomes apparent when the vessel is placed in the magnetic field.

All the phosphorescent effects produced at low temperatures formerly described are intensified at the much lower temperature of boiling hydrogen. To stimulate phosphorescence at the temperature of liquid air, ultraviolet light had to be employed, and then the solid body organic or inorganic, allowed to rise in temperature. It was during the rise of temperature that the marked luminous emission took place. Among inorganic bodies the platino-cyanide of ammonia is very remarkable in this respect, and generally the group in organic chemistry known as the ketonic bodies. In the case of bodies cooled in liquid hydrogen, it appears that some show phosphorescence by simple stimulation with the light coming from an ordinary carbon filament electric lamp. The light in this case coming through glass contains only, we may say, the visible spectra, so that the ultraviolet rays are not now essential. It is strange to find photographic action still relatively considerable. At the boiling point of liquid air the photographic intensity is reduced by 80 per cent of the value at the ordinary temperature. The photographic effect on a sensitive film immersed in liquid hydrogen as compared with the same placed in liquid air is as 1 to 2, so that 10 per cent of the action at ordinary temperatures still remains. As every kind of chemical action so far examined is non-existent at this extreme temperature, these experiments suggest that the cause of the photographic action may be essentially physical. No better illustration could be given of the rapid diminution of chemical action at low temperatures than to remind you that fluorine gas, the most active elementary body, under such conditions may be liquefied and kept in glass vessels.

The effect of a temperature of 21 deg. absolute on the electric resistance of the pure metals is a problem of great interest. In passing from the melting point of ice to the boiling point of hydrogen, pure platinum loses resistance till only one-fortieth remains, and in the case of electrolytic copper the remaining resistance is only one fifty-seventh of what it was at starting. Such results suggest the approach to the condition of what may be called relatively perfect electric conductivity as the zero of absolute temperature is approached.

Liquid hydrogen is a non-conductor of electricity, and as regards being an insulator for currents of high potential it is comparable to that of liquid air. The properties of the liquid we have witnessed in no way suggest the metallic character that chemists like Faraday, Dumas, and Graham anticipated; and for the future hydrogen must be classed with the non-metallic elements.

The liquefaction of hydrogen has been the consequence of some ten years' devotion to low-temperature research. To many it may seem that the results have been indeed costly in more ways than one. The scientific worker who prepares the way for future development in this sort of inquiry generally selects complicated methods, and is attracted or diverted into many bypaths of investigation. He may leave to his successors any credit that may be attached to cheapness and ease of production of the agent of research—results that must invariably follow. Liquid hydrogen is an agent of research which will enable us to examine into the properties of matter at the lowest-maintained temperature ever reached by man. Much work has still to be accomplished. One of the most fascinating problems of the study of low temperatures has been materially advanced. The interval separating us from the zero of absolute temperature has been reduced to practically one-fourth the value that it stood at when liquid air was the cooling agent. We can produce in pure helium instantaneous temperatures, bringing us still nearer the goal. Now we can maintain a temperature within less than 16 deg. of this zero, and the investigator who will make the further attempt to reduce this distance by an equivalent amount, thereby reaching a steady temperature of 4 deg. or 5 deg. absolute, will indeed face a problem of almost insuperable difficulty. Well, let us take comfort in an aphorism of Davy's: "Fortunately for the active and progressive nature of the human mind, even experimental research is only a method of approximation to truth."

The success of the demonstration has been largely due to the unremitting exertions of my chief assistant, Mr. Robert Lennox, and to the valuable aid given by Mr. J. W. Heath.

FATIGUE IN ARMY HORSES.

THE Annales de Sanidad Militar, of Buenos Aires, Julio, 1901, says that very good results have been obtained from the use of sugar to overcome the great fatigue in horses when overworked.

The horses employed in the service of the National Military College in transacting the business of the establishment are exposed, during the rainy season, to great strain and consequent exhaustion, in consequence of the bad condition of the roads and the increased amount of transportation due to certain conditions then prevailing.

For this reason many horses, in past years, have succumbed to the excessive strain, very many became sick, pathogenic microbes found in the prevailing conditions favorable fields for their development, and fatigue caused great loss of appetite, loss of flesh, pulmonary lesions, cardiac disturbance, nervous trouble, etc.

The good results obtained by military surgeons from the use of sugar in large doses in forced marches led me to employ it for the purpose of overcoming great fatigue in the horses employed in my service.

The favorable reception given to my suggestion by my superiors encouraged me to experiment with great freedom, and I was able to give to horses that were subjected to great strain 200 grains of sugar daily, mixed with their food, and distributed regularly throughout the day.

The results obtained have surpassed my expectation, for not only has the fatigue manifested by the horses in this service disappeared, but many of the animals, until the present useless in consequence of their miserable physical condition, have recovered their normal strength, and are now rendering good service.

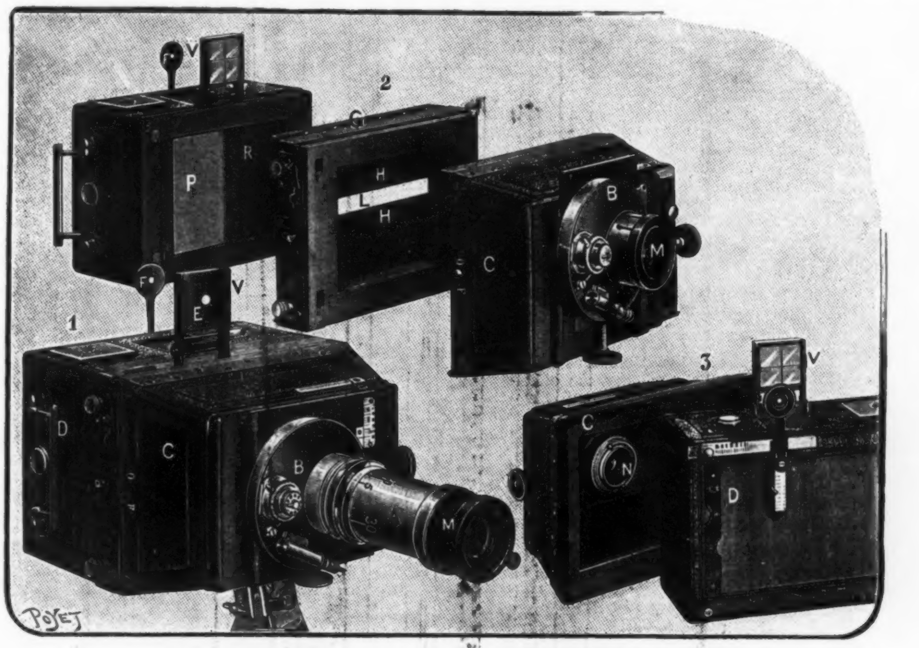
Although this experiment has not the force of a prolonged test, I deem it advisable to publish it because I think that in certain cases sugar is destined to yield important service as a special agent, to supply strength that has been exhausted by excessive exertion.

JARGE KRYEMBIELH,
Veterenario de Ira Clase.

Hospital Militar, Junio 27, 1901.

THE BELLIENI TWIN LENS CAMERA.

M. BELLIENI, of Nancy, has added to his well-known twin lens cameras various improvements that justify the name of "Universal" that he has given them. He has adapted to them, without increasing their bulk, an ordinary shutter and a plate shutter that may be employed at will and according to circumstances; a large angular objective of 4.1-inch focus or an anastigmatic objective of 5.2-inch focus; and, finally, a long-distance objective that magnifies eight times and gives images of remarkable sharpness. The apparatus represented in the accompanying figure (No. 1) is 3.5 by 4.6 inches in size, and is provided with a magazine, *D*, that holds 12 plates, a finder, *V*, and a sight, *F*, provided with a graduated scale corresponding to one on the objective holder, which may be moved in two directions. By making use of the finder the subject may be centered upon the plate without any difficulty, whatever be the shifting that has to be done in order



THE BELLIENI "UNIVERSAL" TWIN-LENS CAMERA.

to have it in its entirety. The magazine (No. 2) is provided with a slide, *R*, which covers and uncovers the plate *P*, at the moment desired. This arrangement permits of taking out the magazine in broad daylight in order to substitute another for it or to carry it into the dark room. Immediately in front is adapted a plate shutter consisting of a curtain, *H*, provided with a slit, *L*. When it is not desired to utilize this it is wound up on its roller so as to leave the frame, *G*, completely free. It is to the latter that is adapted the camera, *C*, which carries the ordinary shutter, *B*, and the anastigmatic objective, *M*. In the interior (No. 3) and behind the shutter is placed the large angular objective, *N*. Naturally, the one of the two objectives that the operator does not desire to use is unscrewed and removed, but the same shutter is used for both. Finally, by removing both objectives there may be screwed to the shutter, *B*, the long-distance objective, *A* (No. 1), to which has previously been adapted the anastigmatic objective, *M*, of 5.2-inch focus.

The use of the long-distance objective is old; but, up to the present, in France, at least, we do not think that it has ever been employed with a twin lens camera. Nevertheless, there are many cases in which the operator would be pleased to have it in his power to obtain an image of large dimensions, despite the distance at which he is obliged to station himself. The optical combination adopted by M. Bellieni is that of Zeiss, which permits of taking an instantaneous photograph in about a tenth of a second in clear weather. The sharpness is such that a 12 by 16-inch amplification of the negative can afterward be very easily made.

Provided with a twin lens camera thus arranged it ought never to be impossible for a person to obtain a negative. If there is but little light, or if it is a question of taking an instantaneous photograph of a quickly moving object, the objective shutter, *B*, must be opened and the plate shutter, *G*, be used. If there is not room enough to allow him to move backward the operator must employ the angular objective, *N*, after unscrewing the other. Then the sub-

ject must be centered upon the plate in referring to the graduated scales of the sight, F, and the objective holder. Finally, if, after taking a general view, it is desired to have enlarged details of a part of it, the long-distance objective, A, must be put in place. In this case the finder can again be utilized provided it be covered with a plate of sheet iron, E (No. 1), containing an aperture for limiting the image given by the apparatus.—For the above particulars and the engravings we are indebted to La Nature.

RUDOLPH KOENIG.

ON the second day of October, 1901, Rudolph Koenig passed away at his home in Paris in his sixty-ninth year. He had been in failing health for several years.

Rudolph Koenig was born in Koenigsberg, Prussia, on the 26th of November, 1832. At his home he received nothing beyond the usual high school training given in the local gymnasium, in which his father was the teacher of mathematics and physics. He went to Paris at the age of nineteen years, and in the French metropolis he spent most of his manhood. Here he began life as an assistant in the manufactory of a celebrated violin maker, Vuillaume, where he manifested unusual aptitude both as a mechanician and as the possessor of an extraordinary delicate and correct ear for music. Such leisure as he could command was devoted to the study of mechanics and physics.

Within a half dozen years the young acoustician was enabled to undertake business on his own account, having already attracted the notice of men of science by his ingenuity, patience and accuracy. In 1859 he issued his first catalogue of acoustic apparatus. From that day to the present Koenig's instruments, and especially his tuning forks, have been generally recognized as standard.

Koenig was not satisfied to fill orders and maintain his reputation as a constructor of instruments. He early perceived the value of the graphic method for the study of harmonic motion, and to this he devoted much time and labor during the first few years after establishing himself independently. Wertheim and Duhamel had already used the tuning fork with style attachment for the registration of simple vibrations, as suggested a half century previously by Dr. Thomas Young in England. Koenig extended it to the study and registration of compound harmonic motion for both parallel and rectangular vibrations. The mathematical analysis of wave motion had been abundantly brought out in technical treatises, and Lissajous had but recently excited admiration by his optical method of presenting rectangular vibrations. Koenig devised the method of recording these directly from the sounding tuning fork. At an international exhibition held in London, in 1862, he exhibited an album containing a large variety of such phonograms, recorded with apparatus of his own device, and accompanied with the tracings of the corresponding theoretical curves. This was the starting point for the use of the graphic method of self-registration which has since been so extensively employed in laboratories of physics, physiology and psychology.

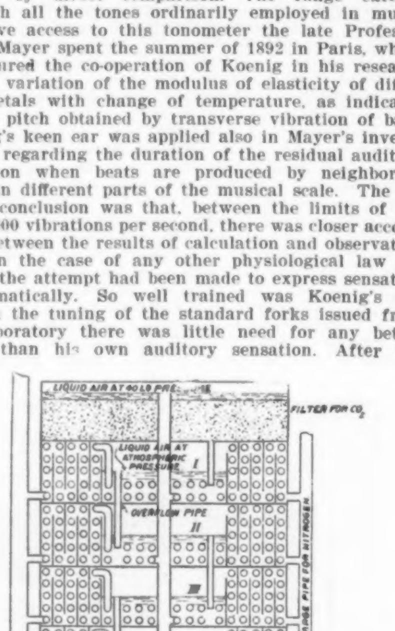
It was at the same exhibition that Koenig made known a wholly new method of causing the effects of sonorous vibration to become visible by utilizing the delicate sensitiveness of flame to variations of atmospheric pressure. The suggestion had come from America, where Le Conte had published, in 1858, his observations on the effect of sound waves upon naked gas flames. Koenig devised the manometric capsule, and resorted to Wheatstone's application of the revolving mirror for spreading the flame images. The last improvements on this method have been made by the application of instantaneous photography to perpetuate the images, some of the best of this work having been done within the last few years by Hallock in New York and Merritt in Ithaca. The manometric flame is not equal to the tuning fork curve as a means of studying the composition of vibration, but the novelty and attractiveness of the method quickly made its author famous. He received a number of medals, and in 1868 the honorary degree of doctor of philosophy was conferred upon him by the university of his native city, Koenigsberg, in acknowledgment of his meritorious original work in science.

Prior to 1882 Koenig had published about sixteen scientific papers, some in the Comptes Rendus, but most of them in the Annalen of Poggendorff and Wiedemann. These were gathered into a volume entitled "Quelques expériences d'acoustique." Since that time he has published a number of contributions to Wiedemann's Annalen, the last of which appeared in the summer of 1899. Failing health had already put a check upon his activity, but his passion for experimental research continued long after the time when most men lose their enthusiasm for abstract investigation. All his research work was the outcome of the love of science without the promise of pecuniary reward. It was done, moreover, with full knowledge that as a branch of pure science acoustics had been forced to the background by such subjects as heat, and more especially electricity, in which the field has become widened almost without limit during the last two or three decades.

In the absence of systematic university training in early manhood, Koenig as an investigator in physics was compelled always to work at some disadvantage. He had an abiding faith in experiment, and was not afraid to proclaim the results of his careful, painstaking work, even if it seemed to contravene the conclusions of those whose theoretic preparation was better than his. The subject of musical quality was one which he attacked with characteristic patience. With the mathematical theory of combination tones, as brought out by Helmholtz, and the two subdivisions of difference tones and summation tones, Koenig was not prepared to grapple. With his naturally acute and highly trained ear he sought in vain to perceive the summation tones for which theory provided, and he reached the conclusion that they had no objective existence. Difference tones, or beat tones, as he called them, are easily perceived, and he spent much time in the investigation of such tones due to the interference of upper partials. It was in furtherance of this investigation that he invented the wave siren; and as a result of experiment with it he concluded, in opposition to the view of Helmholtz, that musical quality is determined not only by the number, the orders and the relative intensities of the upper partials which accompany a given fundamental tone, but also by their mode of phase combination. To test this the wave siren was certainly better than the apparatus employed by Helmholtz; but the perception of the result requires an experienced ear. The experiment is more psychological than physical. Upon the present writer, while co-operating with Koenig in his laboratory, and upon others also, the decided impression was that Koenig's conclusion was correct. But the subject is still one for investigation.

A monumental piece of mechanical work accomplished by Koenig was his great tonometer, consisting of hundreds of accurately adjusted and properly labeled tuning forks arranged in a series, each making a definite and small number of beats with the preceding and following ones, so that the frequency of any source of sound approximately simple can be at once ascertained by direct comparison. The range extends through all the tones ordinarily employed in music. To have access to this tonometer the late Professor A. M. Mayer spent the summer of 1892 in Paris, where he secured the co-operation of Koenig in his research on the variation of the modulus of elasticity of different metals with change of temperature, as indicated by the pitch obtained by transverse vibration of bars. Koenig's keen ear was applied also in Mayer's investigation regarding the duration of the residual auditory sensation when beats are produced by neighboring tones in different parts of the musical scale. The author's conclusion was that, between the limits of 100 and 4,000 vibrations per second, there was closer accordance between the results of calculation and observation than in the case of any other physiological law for which the attempt had been made to express sensation mathematically. So well trained was Koenig's ear that in the tuning of the standard forks issued from his laboratory there was little need for any better guide than his own auditory sensation. After the pitch had been provisionally attained in this way it was corrected by other and more exact methods, but the correction was always very small.

It seems scarcely probable that Koenig will have any successor. For a man now to devote his whole life to the science of acoustics would be a piece of specialization for which but little reward can be expected. The progress of science has its phases of relative importance, and that of acoustics seems now to be past. Koenig is dead, and his friends will remember him with affection and respect. His devotion to acoustic science was unique. His life was that of the recluse bachelor, and his later years brought anxiety and privation because his science had lost its value as a means of support. He will not soon be forgotten; but likewise no one will aspire to take his place.—W. Le Conte Stevens, Washington and Lee University, in Science.



PICTET'S OXYGEN SEPARATION PROCESS.

PICTET'S OXYGEN SEPARATION PROCESS.

M. RAOUL PICTET, the well-known Geneva physicist, has recently brought forward a plan for separating oxygen from the air, on a commercial scale, by means of a process of fractional distillation. If liquid air is allowed to evaporate, the gas which first comes off is almost pure nitrogen, while after nine-tenths of the liquid has evaporated, the remaining tenth is nearly pure oxygen, which can be collected and stored in any suitable receiver. The production of liquid air, in the first place, is, of course, a somewhat expensive operation, but by a system of heat interchanges M. Pictet utilizes the gases evaporating off to lower to the point of liquefaction the fresh supplies of air passed into his apparatus; so that were it possible in practice to make use of perfect conductors of heat for the coils of the interchanger, and of absolute heat insulators to prevent the passage of heat in from the exterior, the apparatus would work indefinitely without any diminution of the original charge of liquid air. In actual practice, however, it is impossible to avoid leakages of heat; and it is therefore necessary to maintain a constant supply of energy to the apparatus, sufficient to compensate for the loss of liquid air evaporated by heat flowing in by conduction, or by heat generated by the friction of the moving fluids in the interchanger. This supply of energy is readily afforded by keeping the air in the inlet pipes under a pressure of 30 pounds to 40 pounds per square inch, while the exhaust takes place at atmospheric pressure.

M. Pictet's plant is represented diagrammatically in the annexed figures. It consists of ten stills, numbered I to X in the diagram. These, it will be seen, are placed in a pile, one above the other. At starting, each is filled with liquid air to a level fixed by an overflow pipe, the overflow from each passing through this pipe into the still below. Immersed in the liquid in each still is a coil of piping represented by the series of small circles. Each of these coils opens at one end into a central vertical pipe passing through the whole column of stills into a filter chamber at the top. At the other end, each coil is continued by an interchanger coil, forming a series of windings round the central chamber of each still, and terminating at the inlet main shown to the left of the diagram. By means of heat insulating partitions between the successive windings of the interchanger coils, the gases evaporated from the liquid in each still flow round these coils as they pass out from the apparatus. An interchange of heat therefore takes place between the fresh supply of air entering the still through the coils and the outgoing gases. By using sufficiently long coils this interchange can be made practically complete, so that on their final escape from the apparatus the gases evaporated are at ordinary atmospheric temperature, while the incoming air on reaching the central chamber of the still has been reduced to a temperature corresponding to the boiling point of the liquid in the still. The latter is, however, at atmospheric pressure, while the incoming air is at a pressure of some 40 pounds per square inch, and accordingly condenses to a liquid. The latent heat set free in these condensations passes out through the walls of the submerged coils, and evaporates a corresponding amount of the liquid in the still. The liquefied air passes next from the submerged coil into the vertical pipe, and is delivered into a filter at the top of the apparatus, as already explained. In passing through this filter, the solidified carbonic acid gas is strained out, and may be collected for bottling. The liquid passing through the filter is delivered into No. 1, the topmost still. Since, however, this still receives the whole amount of the incoming liquid, and only performs one-tenth of the total evaporation, nine-tenths of what it receives passes on to No. 2 still by the overflow pipe, and similarly for the remaining stills of the series. Nitrogen has a boiling point of about —195 deg. C., while oxygen boils at —183 deg. C. This difference of 12 deg. C. at these low temperatures is proportionately as great as one of 40 deg. C. at a temperature of 60 deg. C. Hence, in the top still practically pure nitrogen is alone evaporated, and as a consequence the liquid in this still contains more oxygen than an equivalent weight of common air. A portion of this liquid passes over into No. 2 still, as already explained. In this still, again, next to no oxygen is evaporated, so that the overflow to No. 3 still contains proportionately even less nitrogen than that from No. 1. This holds throughout the series; the liquid as it passes down the column through the overflow containing less and less nitrogen as it approaches the bottom still, the contents of which consists of oxygen to the extent of well over 90 per cent. The distillate from the five uppermost stills is 90 per cent nitrogen. In that from stills Nos. 6 and 7, the nitrogen is in about the same proportion as in common air, while from the remaining three stills the discharge analyzes 55 per cent of O. In certain cases it may be convenient to collect separately the distillate from No. 10, since this is over 90 per cent O; but for many industrial uses the gas obtained by combining the discharge from the three lower stills will serve every purpose.

Certain precautions are needed in the purification of the air before it enters the apparatus, as it is essential that it shall be quite free from moisture, which would deposit as ice and clog the interchanger coils. This moisture M. Pictet extracts by cooling the air well below the freezing point of water by an auxiliary refrigerating plant. The moisture in it can be thus deposited in some readily accessible chamber, and the pure dry air passed on to the distilling plant.

The commercial importance of a really cheap method of preparing oxygen on a large scale can hardly be overrated, as it would lead to an enormous saving in fuel, particularly in the case of metallurgical operations. In many of these, the desideratum is temperature rather than heat units. The specific heat of nitrogen is high, and as this gas forms three-quarters the weight of ordinary air, the temperature attained in the air furnace is limited, and is far below what can be obtained by burning the same fuel in an atmosphere of oxygen. Hitherto, the great cost of oxygen has prevented any attempt to replace air by this gas in industrial operations; but M. Pictet hopes that with his new plant the cost may be reduced sufficiently to render the substitution commercially possible. With a plant treating some 500 tons of air per day, he estimates that 110 tons of a distillate containing over 50 per cent of oxygen could be obtained. At the same time about 0.25 ton of solid CO_2 would be collected, which could readily be increased up to two or three tons if desired, by adding washed furnace gases to the air supply entering the apparatus. At one-third of present prices for liquid CO_2, this by-product would, M. Pictet claims, pay the whole of the expenses of working. Assuming, however, that no market could be found for this product, the cost per 1,000 cubic feet of 50 per cent O would, making due allowance for interest on capital depreciation and the like, not be more than about 1½d. per 1,000 cubic feet; while if 90 per cent oxygen alone were produced, its cost would be 3½d. per 1,000 cubic feet. The power required to run such a plant would amount to a total of nearly 700 horse power, of which 100 horse power would be needed for the refrigerator used in de-hydrating the air. For metallurgical operations in which the final product is carbon monoxide, the plant in question should theoretically suffice to burn 110 tons of coke per day.—We are indebted to the London Engineering for the above description and engraving.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Germany's Food Products.—The proposed change in the German customs tariff, particularly the high duty on food stuffs, has been severely criticised from all sides, except one. Germany has not the natural resources to supply her people's demand for meats and agricultural products. With a constant increase in population, and in the evolution from an agricultural to an industrial country, it is quite natural that the demand for food would advance and the production decrease. Three decades ago, Germany's demand did not exceed her supply; on the contrary, there was a much larger export than import of food stuffs.

The census of 1895 placed the Empire's population at 52,279,901, while the census of 1900 was 56,345,014, an increase of 7.8 per cent over 1895, or 37.2 per cent over the population of 1871.

During the year 1900 Germany had a total import of 7,446,300 tons of agricultural products and meats, valued at 1,762,800,000 marks ($419,546,400); while her export of similar products amounted to 2,659,300 tons, valued at 517,600,000 marks ($123,088,800).

Of Germany's total import for 1900, wheat forms 2.8 per cent; corn, 2.1 per cent; rye, 1.6 per cent; oats, 0.8 per cent. The total value of all imports from the United States for the same period amounted to 1,020,-000,000 marks ($242,950,400), or 16.9 per cent of the Empire's total import. The total export to the United States amounted to 439,700,000 marks ($104,648,600), or 9.3 per cent of the entire export during the year in question.

The first effect of an increase over the present import duty on food stuffs will be an advance in price of these articles. The cost of living is at present from 10 to 50 per cent higher than in the United States, while wages are about one-third of those paid at home. To balance the increased cost of living, wages must be increased, which will again enhance the cost of production and the selling price, thus placing the burden of the new duty on the people in general.

In connection with the effect of an increased duty on the American export to Germany, the following official marine statistics will be of interest:

During 1899, 1,058 steamers, with 2,690,313 registered tons, out of a total of 2,336 vessels,* with 4,913,178 registered tons, were entered at German ports as arrivals from ports of the United States. As to departures to non-European ports, 1,712 vessels, with 3,870,931 registered tons, were cleared; out of this total, 714 steamers, with 2,110,252 registered tons, were bound for the United States. The export from the United States to Germany for the year 1900 amounted to 4,500,000 tons. I have no figures to show the nationality of the vessels conveying this immense cargo, but I am certain that American bottoms did not carry 30,000 tons, and that a conservative estimate would give German bottoms two-thirds of the whole. The 3,-000,000 tons, if estimated at an average freight rate of $3 per ton, would show $9,000,000 paid by American exports to German shipowners during 1900.—John E. Kehl, Consul at Stettin.

American Products in Austria-Hungary.—Imports into Austria-Hungary from the United States are increasing rapidly. American exporters have not, until recently, given general attention to this part of Europe, which is considerably removed from ports in closest touch with trans-Atlantic commerce. Although the total amount exported from the United States during the year 1900 to this monarchy amounted to some $30,-500,000, the sum is, nevertheless, capable of being enlarged. This probability is understood in Austria, and the prospect is not complacently regarded. Austrian manufacturers and agriculturists are making an organized effort to stem the inflow of American products, and within the week an important conference has gathered in Vienna to take measures against our competition. The movement can not be called determinative; it shows, however, the attitude of an influential and educated minority. It is the producer, rather than the consumer, who endeavors to place himself on the defensive. Mention is often made here of a protective league, comprising Austria-Hungary, Germany, Switzerland, Holland, and Belgium, against the United States, although it can not be seriously considered. At the assembly in question, composed of leading men discussing how American imports can be effectually restricted, it was openly acknowledged that the commercial policy of the present time is dictated and controlled by the United States. Austria is threatened with formidable shipments of goods that tend to dwarf, if not actually destroy, many Austro-Hungarian industries. Especially does the Austro-Hungarian agriculturist cry out against the imports from the United States of flour, corn, lard, bacon, ham, and fresh fruits—articles that the Argentine Republic, Russia, and the Balkan States also ship to Austria-Hungary. Although, as yet, there has been no extensive unloading of American coal at either Trieste or Fiume, it is feared that the United States will soon begin to carry anthracite to the Austrian and to the Hungarian seaports. Iron, steel, and machinery have already established themselves on a commercially profitable basis. Instances of the gigantic strides of our American manufacturing industries are cited, to show our ability to forge ahead of all competitors in many fields. American trusts are particularly mentioned as a mortal peril to European manufacturers, on account of the powerful organization of capital and business manipulation.

As means to ward off encroaching American competition in Austria-Hungary, it is recommended, in view of the commercial policy of the United States and the present customs movement of the German Empire, that there be an entire reconstruction of the Austro-Hungarian tariff system, so that sufficient and lasting protection may be granted to manufacturers and agriculture. At the same time, it is said, this new tariff must be specialized in the most far-reaching manner. It should contain sufficient concessions to facilitate the conclusion of favorable commercial treaties, and to develop Austro-Hungarian exports. The usual most-favored-nation clause in the new commercial treaties should no longer be inserted, and, on the other hand, certain paragraphs should be added which will give reciprocal advantages. In view of the rapid changes that are likely to occur in the field of commerce, the manufacturers and agriculturists consider it advisable to determine the duration of the treaties according to the productive conditions of the various states with which they may be concluded. They demand that treaties protecting domestic industries in a satisfactory manner and stimulating export should be subject to termination at long notice, but that a commercial treaty with the United States of America should be subject to short notice.—Carl Bailey Hurst, Consul-General at Vienna.

* Vessels from non-European countries only.

Business Training for Americans in France.—In view of the fact that we are finding new markets abroad for our products, I would call the attention of our manufacturers and exporters to one method the European exporter employs to extend and retain trade—a method which, so far as western France is concerned, has been almost entirely ignored by us. The young men of the United States should be given a practical business training abroad. It is just as essential that the American should have a knowledge of foreign business methods as for him to have a knowledge of the foreign language. These two trade weapons should go together when markets are to be conquered. Although our enterprise and progress are acknowledged, and we have attained a place in the foremost ranks in the commercial world, we can not expect to force our crisp and rapid business methods upon the conservative Frenchman. We may gradually convince him of the superiority of our system, but we must in the beginning make certain concessions. Our young men should come to France and obtain employment in some of the large business establishments for six months, one year, or two years, as the exigencies may require. True, wages are low here, but doubtless a number of young men could obtain employment which would at least pay their board, and the experience thus obtained would be beyond value. Large manufacturing and export houses could send young men abroad. In this city of 200,000 inhabitants I know of but one from the United States who is engaged in business, and he is with a retail firm. Young men from England, Wales, Belgium, and Switzerland are here temporarily, with the leading import houses, getting a practical knowledge of the language and of French business methods. Especially is this true of the coal and the wholesale commission trades, where deals are made for phosphates, lumber, and grain in cargo lots. In such positions these young men are often able to give valuable pointers to the exporter from their own country. They usually attend to the correspondence from their respective countries, study French, and obtain an insight into the metric system and French peculiarities in business. I am convinced that the sale of American coal in France during the past year would have been doubled had it not been for lack of information on the part of the American producers concerning French trade, and their consequent inability to meet the requirements promptly on this side.—Joseph I. Brittain, Consul at Nantes.

Industrial Conditions in Madagascar.—Official reports from Madagascar show the following condition of affairs there at present:

The wood industry has already been introduced into the Province of Manjakandriana, there being a camp with two heavy lumber machines, three saws, and two planing engines. The capital required was about $200,000.

In Andrangoloaka there is an iron mill, but not of a modern type. The proprietor of this concern has also a wood-cutting concession. A brickmaking establishment exists in the Province of Majunga; there is also an iron foundry, an ice-making plant, a printing office, and two big sawmills. All of these industries were started by French capital.

New undertakings which it would pay to establish are a rice-shelling factory, a modern steam laundry, a brewery, a lemonade factory and a leather tannery.

A capital of from $4,000 to $5,000 would suffice for the erection of a new ice plant. An immediate market for its product could be had outside of Majunga in all the neighboring ports of the southwest coast.

Small brickyards require no great capital and would yield good profits. Rice shelling recommends itself on account of the little machinery to be used; for such an establishment $3,000 capital would suffice. At the present moment there are no laundries in the country, the washing being done with cold water by the primitive native method of pounding on stones.

Tanning materials are easily obtained from the various kinds of native bark. A tanyard in or near Majunga to prepare the local hides before shipment would no doubt be a paying investment.

The European beer which is imported at Majunga arrives often in very poor condition, and costs 35 to 50 cents per half-liter bottle. If a brewery with a capital of about $20,000 to $25,000 were established, to provide a good wholesome beer at reasonable prices, it would be a success from the start.—Oliver J. D. Hughes, Consul-General at Coburg.

American Locomotives in Bavaria.—The Berlin Neueste Nachrichten of October 29 contains a telegram from Munich concerning the results of the experience of the Royal Railway Administration with American locomotives, of which the following is a translation:

"The general administration of the Bavarian State railways ordered and received from the Baldwin Locomotive Works, in Philadelphia, two express passenger locomotives, which have been in use nearly three-fourths of a year. The difference between these locomotives—which are easily recognized by their unearthly whistle—and the German engines consists principally in the fact that they have on each side three cylinders, placed vertically one above the other, and cast in one piece with the valve chests and saddle. In other respects, the American machines are characterized throughout by the greatest simplicity in all parts, and their management differs very slightly from that of any other locomotive."

Since they were placed in service, the methods in which the steam power acts and the general efficiency of the locomotives have been very carefully observed. The result of all these tests and observations has been entirely satisfactory. The general direction has now, as is announced by the Munich Allgemeine Zeitung, secured the patent of the American Vauclain, and authorized the construction of a locomotive according to this system, with certain modifications, by each of the two firms Krauss & Co., of Munich, and J. A. Maffei, of Hirschau. These machines are now in process of construction, and it will depend upon their efficiency and durability whether the system shall be further utilized. The cost of the Bavarian locomotives will be about 20,000 marks ($5,760) greater than that of the American.—Frank H. Mason, Consul-General at Berlin.

New Acetylene Generator in Sweden.—Mr. Erik Cornelius, chemist at the Carbide Factory at Trollhättan, Sweden, has invented a new acetylene-gas generator, called the "Trollhättan."

This generator is said to be much simpler in construction than former ones, and occupies little space. The falling of the carbide into the water is automatically regulated by a rubber ball, which, as soon as it is filled with gas, closes the valve between the carbide and the water. When the volume of gas decreases, the hollow rubber ball contracts and the feed valve again permits the carbide to drop. The gas is stored partly in the rubber ball and partly in the space between the funnel-shaped carbide magazine and the water. If much gas is generated, the water is pressed through valves into the water jacket in the sides of the apparatus, thus furnishing more room for the gas. A separate gas tank is therefore not needed. Should too much gas be produced, water and gas escape through a safety valve. Common carbide is used; no cartridges. The gas is dried by being allowed to pass through the carbide magazine, where the carbide absorbs the moisture. As there is no gas tank, and the quantity of gas stored thus is insignificant, it is considered that the fire insurance companies will, without raising the insurance premiums, approve of the apparatus, even when it is placed in dwelling houses.—Robert S. S. Bergh, Consul at Gothenburg.

Demand for Pitch in Marseilles.—The Compagnie des Mines de la Grande Combe, 17 rue Haxo, Marseilles, inform me that they are desirous of receiving offers to supply about 5,000 tons of coal-tar pitch, for immediate delivery at the port of Marseilles or Cette. This company's annual needs amount to 30,000 tons, and if satisfactory arrangements can be made the contracts will be placed in the United States.

The Compagnie des Mines de la Grande Combe have heretofore placed their contracts for tar (brai) in England, and they intimate to me that if American exporters can deliver this article in Marseilles or Cette for less than 47 francs ($9.07) per ton, it will not be difficult to come to terms. These buyers supply samples to importers, and require that deliveries be in conformity therewith. This merchandise is not packed in barrels by the English exporters, but is dumped into the vessel's hold, like coal. It is probable that a freight rate about on a level with that demanded for coal could be obtained for pitch. My latest quotations for whole cargoes from the United States to Mediterranean ports are 9s. 6d. ($2.31), and still better offers have been made quite recently.—Robert P. Skinner, Consul-General at Marseilles.

Foreign Demands for American Coal.—Consul-General Skinner reports from Marseilles, October 24, 1901:

Messrs. D'Artoz Petiaux & Co., 22 rue de la Rotonde, Marseilles, controlling the Société des Comptoirs Franco-Ethiopiens, write to me, under date of October 24, as follows:

"We are upon the point of opening a coal depot at Djibouti, Red Sea, where are located the headquarters of our establishments, and we ask you to be kind enough to indicate to us, or to put us in relations with, some important miners of American coal, either for purchase or consignments."

I have received similar inquiries from the following firms: M. Prosper Lauze, 59 rue Fabrerie, Alais, Gard; Señor Olivares, Acequia, 12, 1°, Barcelona, Spain; Monsieur Epercieux, 79 rue Nationale, Firminy, Loire.

The labor situation, as respects the mining industry in France, is in a very troubled state, and it might be well for American exporters to familiarize themselves with conditions in this country.

Peat as Fuel for Locomotives in Sweden.—Consul Bergh sends the following from Gothenburg, October 30, 1901:

The Vislanda-Bolmen Railroad, Sweden, made a few days ago an experiment with pressed and dried peat as fuel with an extra train consisting of locomotive, fifteen loaded freight cars, and one passenger car. The distance was about 22 miles, and the time-table was set for lower speed than the ordinary, but this extra train arrived in due time at the respective stations, and at the final station fifteen minutes ahead of time. Considering the fact that the locomotive in use was built for using coal only, the result of the trial is regarded as very satisfactory.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Glass Ink, which is not effaced by water, is prepared as follows according to Praktische Mittheilungen fuer Handel und Gewerbe.

Turpentine	15 parts.
Shellac	10 parts.
Venice turpentine	3 parts.
Fine lampblack	3 parts.

To Paint Wrought Iron with Graphite.—In order to make wrought iron look like new, procure fine graphite and stir it like any other pigment with equal parts of varnish and turpentine oil, adding a little siccative. Paint the iron parts with this twice, allowing to dry each time. Especially the second coating must be perfectly dry before further treatment. The latter consists in preparing graphite with spirit and applying it very thinly over the first coat. After the drying or evaporation of the spirit the graphite last applied is brushed vigorously, whereby a handsome, durable gloss is produced.—Deutsche Malerzeitung.

New Hardening Agent for Steel.—The new hardening agent consists in a liquid in which the steel heated to redness is cooled. The liquid is obtained by dissolving quicksilver and yellow prussiate of potash in nitric acid and may be employed in any desired degree of dilution with water.

For 1 liter of hardening liquor take, for instance: 250 grammes of quicksilver, 20 grammes of yellow prussiate of potash, 800 grammes of nitric acid and 150 grammes of water. In order to avoid the formation of a large quantity of fumes, when the substances are united the mercury is first dissolved in 600 grammes of nitric acid and the rest (200 grammes) is used for dissolving the yellow prussiate of potash. Both solutions are then mixed together with addition of water. The solution of the mercury in nitric acid increases the hardness of the steel.

Yellow prussiate of potash has the following action upon steel: Proceeding in the same manner as in hardening iron by heating the steel, sprinkling it with powdered yellow prussiate of potash and then quenching with water, a steel is obtained which cannot be used for tools, for the reason that it would split in use as though it had been burnt. If, on the other hand, a solution of yellow prussiate should be allowed to act upon the hot steel, there would be no hardening, nor would there be any with iron. This shows that yellow prussiate of potash is useless for hardening steel, and that especially in the dissolved state it has no hardening action upon steel. Therefore yellow prussiate of potash is not intended as a hardening agent—for this the mercuric nitrate is employed—but its mission is to take away the brittleness from the steel and to impart to it a certain degree of ductility—Neueste Erfindungen und Erfahrungen.

Consistent Machine Oil.—Melt in a kettle holding two to four times as much as the volume of the mass which is to be boiled therein, 10 parts, by weight, of tallow in 20 parts of rape oil on a moderate fire, add 10 parts of, if possible, freshly and well-burnt lime slaked in 30 or 40 parts of water, increase the fire somewhat and boil with constant stirring until a thick froth forms and the mass sticks to the bottom of the kettle. Especially toward the end it should be prevented from burning by diligent stirring. Then add in portions of 10 parts each, gradually, 70 parts of rape oil and boil with a moderate fire, until the little lumps gradually forming have united to a whole uniform mass. With this operation it is of importance to be able to regulate the fire quickly. Now samples are continually taken, which are allowed to cool quickly on glass plates. The boiling down must not be carried so far that the samples harden on cooling; they must spin long, fine threads, when touched with the finger. When this point is reached add with constant stirring, when the heat has abated sufficiently (which may be tested by pouring in a few drops of water) 25 to 30 parts of water. Now raise the fire, without ceasing to stir, until the mass comes to a feeble, uniform boil. In order to be able to act quickly in case of a sudden boiling over, the fire must be such that it can be removed quickly, and a little cold water must always be kept on hand. Next, gradually add in small portions, so as not to disturb the boiling of the mass, 500 parts of paraffine oil (if very thick, 800 to 900 parts may be added), remove the fire, allow the contents of the kettle to clarify, and skim off the warm grease from the sediment into a stirring apparatus. Agitate until the mass begins to thicken and cool; if the grease should still be too solid, stir in a little paraffine oil the second time. The odor of the paraffine oil may be disguised by the admixture of a little mirbane oil.—Industrie Blaetter.

Monochromatic Coatings on German Silver and Platinum.—By Dr. R. Boettger. After innumerable experiments success has been achieved in producing the finest monochromatic shades on platinum and German silver by electrolytic decomposition of organic manganous salts, the metal to be treated being connected with the positive electrode. It had been formerly supposed that it was principally the form of the negative pole that influenced the nature of the Nobili figures. Although this cannot be denied altogether—for with a sharply pointed platinum wire only ring-shaped figures can be obtained—yet the rule is subject to modification with regard to certain manganous salts. With solutions of maganous hippurate, acetate or succinate, even when a very thin platinum wire serves as the negative pole, colored rings are never formed, but a monochromatic coating, in the positive electrode. This has only been observed with these special salts. It further appears that metals which form high oxides, such as lead and manganese, are the best in solution for producing Nobili figures. In using the special manganese salts for obtaining the monochromatic coating, the shape of the negative pole appears to be immaterial; but it is advisable, to secure uniformity of the coating on the positive element, that the negative element should take the form of a disk of platinum. Nothing decided can be said about the strength of the manganese solutions, as the best strength depends upon the power of the current, and must be determined by each experimenter for his own special case. The weaker the current the stronger the manganese solution must be. The color produced changes much and quickly, so that it is essential to instantly break the current when the desired color has been produced. Golden yellow, green, and purple are obtained with particular brilliancy. The metal should be removed from the bath as soon as the current is stopped, rinsed with distilled water, and carefully dried with soft blotting paper. If manganous chloride or lead acetate is used, the colors appear in rings instead of as a uniform layer and of all the colors of the rainbow, in the softest shades, the predominant hues being green, golden yellow and blue, each whole system of rings surrounded by a yellow zone.—Der Metallarbeiter.

The Castability of Metals and Alloys.—As a general rule, pure metals are much less adapted for pouring than the alloys; thus pure copper, pure silver and pure nickel are unsuitable casting materials, since it is possible only in very rare cases to obtain dense castings, while the alloys of these metals can be readily made into the desired shapes by means of the casting process. The behavior of the metals to lower their melting point by alloyage, and thus becoming more readily castable, is utilized especially for difficultly fusible alloys. The difficulty of the production of a casting grows with the melting temperature of the material to be cast. The higher the same is, the more laborious and difficult is the production of the casting mold, the more expensive is the material of the latter, and the larger a quantity of fuel is required to fuse the material to be treated. Metals fusing at a low temperature may be cast with greater ease than those melting at a higher one. Castings of tin, lead and zinc can be produced without the expenditure of trouble, time and material required by those of aluminium, bronze, brass, silver, gold, crude iron, steel, etc. Every medium which is adapted to depress the fusing temperature will also obviate the difficulty of the production of the casting and the danger of a failure of the work. The consistency of the fused metals also exercises great influence upon the use of the material for imparting shape in a liquid state. In the same sense as, for example, water, oil and quicksilver represent different degrees of fluidity, the fused metals also exhibit a different behavior in the liquid state as well as at the transition from the solid into the liquid state. Forgeable iron, platinum and nickel soften before they melt, hence they pass through the stages which may be compared to glass, sealing wax, wax, oil and water, while the metallic alloys change their state of aggregation more or less suddenly. Those metals which soften before melting are as a rule more thickly liquid, even if heated far above their melting point, than the alloys which soften without melting. For this reason, the production of castings from copper is difficult, while the use of bronze for this purpose, hence an alloy of copper and tin, offers no difficulties whatever. Welded wrought iron cannot be poured. The following are best worked up mechanically, but are still susceptible of being poured: Aluminium, copper, gold and silver (including their alloys with copper), steel and ingot iron (the more carbon the better for pouring), German silver, and platinum. Capable of being cast, but also of being worked mechanically are: Lead, tin, zinc, the various bronzes (if the percentage of tin is below 15), brass, antimony-tin alloy (Britannia metal), antimony-lead alloys (if the percentage of antimony does not exceed 10). The following can only be poured: Cast iron, bronzes containing more than 14 per cent of tin, and antimony-lead with a high percentage of antimony (10 to 20 per cent).—Die Edelmetall-Industrie.

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